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U.S. Department of Energy
Idaho Operations Office

Remediation Plans for the Radioactive Waste Management Complex at the Idaho National Engineering and Environmental Laboratory

INEEL
IDAHO NATIONAL ENGINEERING & ENVIRONMENTAL LABORATORY

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ABSTRACT

The strategy for evaluating buried waste at the Idaho National Engineering and Environmental Laboratory (INEEL) under the Comprehensive Environmental Response, Compensation, and Liability Act is described in this report to the congressional defense committees. The waste being investigated is buried in the Subsurface Disposal Area located at the INEEL's Radioactive Waste Management Complex (RWMC). Part of the Subsurface Disposal Area is an operating low-level radioactive waste landfill. Background information, an analysis of waste treatment options, a discussion of contaminant migration, an assessment of the potential suitability of privatization programs to treat waste, an outline of the current strategy for evaluating the RWMC, and the impacts of the Pit 9 cleanup program on remediation of the landfill, are presented. A draft record of decision for remediation of this landfill must be submitted to the U.S. Environmental Protection Agency and the State of Idaho in December 2002.

EXECUTIVE SUMMARY

The U.S. Senate report accompanying the *National Defense Authorization Act for Fiscal Year 1998* (S. Rep. No. 29, 105th Cong. 1st Sess. 428, 1997) contains a request that the U.S. Department of Energy (DOE) deliver to the congressional defense committees a report on remediation plans for the Radioactive Waste Management Complex (RWMC). The RWMC is a DOE waste management facility located at the Idaho National Engineering and Environmental Laboratory (INEEL). The waste under investigation is buried in the Subsurface Disposal Area within the RWMC. Pit 9 is one of the disposal areas within the landfill. The request identified four specific subject areas to be addressed in the DOE report: (1) an analysis of proposed waste treatment options and disposal plans, (2) a determination of the threat of migration of radionuclides and any potential threat to groundwater, (3) an assessment of the suitability of a privatization program to treat waste at the site, and (4) an assessment of the impacts of the Pit 9 project on plans to remediate the RWMC. This report is provided in response to the congressional request.

The U.S. Environmental Protection Agency (EPA) added the INEEL to the National Priorities List on November 21, 1989. The waste buried at the RWMC is a component of the INEEL Superfund site and is being evaluated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). For CERCLA purposes, the entire RWMC has been designated as Waste Area Group 7, which comprises 14 subsets known as operable units. The draft record of decision for Waste Area Group 7 must be submitted to EPA and the State of Idaho by December 2002.

A significant amount of work has been completed on the RWMC investigation. Records of decision have been completed for three components of the site, and additional efforts continue in support of the RWMC comprehensive investigation. The Record of Decision for Operable Unit 7-08 (Organic Contamination in the Vadose Zone) was signed in November 1994 and the remedy has been successfully implemented. Three vapor vacuum extraction units have been collecting and treating organic contamination from the vadose zone through five wells since 1996. Approximately 53,000 pounds of organic contamination have been removed to date. This process is reducing further migration of these contaminants to the Snake River Plain Aquifer. The Record of Decision for Operable Unit 7-12 (Pad A) was signed in January 1994, and the implementation of that remedy has been successfully completed. The implementation of the Operable Unit 7-10 (Pit 9) Record of Decision and the comprehensive investigation of the RWMC are continuing as described in this report. Evaluation of all components of the RWMC, and the potential risk to human health and the environment posed by each, will be completed in conjunction with the overall comprehensive record of decision.

The Pit 9 project was established as an interim action to remediate Pit 9, to provide information about the Subsurface Disposal Area and technologies that could be used to excavate and treat the waste, and to assist in making a sound remedial decision for the entire RWMC. The Pit 9 project was subcontracted under the assumption that "off-the-shelf" technologies were available to successfully perform the project. The Pit 9 project failed. As a result of this failure, DOE sought and was granted an extension of the schedule for the record of decision for the comprehensive investigation of approximately four and a half years from July 1998 to December 2002. As a result of missing enforceable milestones associated with Pit 9, DOE paid $940,000 in stipulated penalties: $100,000 to the EPA and $840,000 to a State of Idaho trust fund to be used for a future environmental improvement project. Furthermore, because the comprehensive investigation still requires data for risk assessment and to ensure that all viable alternatives are adequately explored, DOE is using the extension to gather additional data and to examine the viability of newly emerging in situ remedial technologies. Several of these recently developed technologies appear to have the potential to allow treatment of waste with lower risk to workers, fewer regulatory complications, and reduced cost to the taxpayer.

Some contaminants have been detected in the Snake River Plain Aquifer underlying the INEEL. Preliminary risk modeling indicates that these contaminants will continue to migrate and may present an unacceptable risk to human health in the future, primarily from ingestion of contaminated groundwater. Organic contaminants (primarily carbon tetrachloride), nitrates, neptunium-237, and uranium isotopes in the buried waste appear to dominate the potential groundwater risk.

The types of remedial alternatives being evaluated for the buried waste include containment, in situ treatment, retrieval and ex situ treatment, and a combination of technologies. Containment options include various types of caps, horizontal barriers, and vertical barriers. In situ treatment technologies can be used to treat the waste in place. In situ technologies include physical, chemical, or biological destruction; solidification and stabilization; or a combination of all. In situ thermal treatments can destroy, remove, or stabilize contaminants without excavating the waste. Examples of in situ treatments include in situ vitrification, in situ grouting, in situ thermal desorption, and vapor vacuum extraction. Ex situ treatments are applied to excavated waste. Available categories of ex situ treatment include thermal, physical, chemical, and biological methodologies, and stabilization techniques. Examples of specific ex situ technologies are physical or chemical sorting, vitrification, and incineration. Physical and chemical sorting methods extract contaminants from waste and soil to reduce the volume of materials requiring treatment and disposal. Technologies can be applied in series or in combination to achieve remediation goals. Ultimately, the remedy selected for the buried waste and contaminated soil at the RWMC could be a single alternative or a combination of remedial alternatives. In the past, waste with higher contaminant concentrations was buried in the Subsurface Disposal Area than would be allowed today. Therefore, specific areas within the landfill pose more risk than other areas. Selective remediation for specific high-risk areas in combination with less rigorous remediation of lower-risk areas may be appropriate to safely and efficiently manage the overall risk associated with the site.

Historically, the management and operations contractor has managed projects at the INEEL and, except for construction, used its own employees to implement the projects in facilities financed and owned by the government. Alternatively, under a privatization concept, DOE or the INEEL management and operations contractor could obtain the required remediation services directly from a vendor with specialized skills, technologies, and facilities. However, until the remedial actions have been selected for the RWMC, the suitability of a privatization program for the entire RWMC cannot be analyzed fully. The analysis will be completed when the record of decision is complete and a remedy is selected for the RWMC.

To support the decision-making process, the DOE Idaho Operations Office, EPA, and the State of Idaho have developed a strategy to acquire enough information to evaluate the risk associated with the RWMC and assess applicable remedial alternatives. The budget to support this strategy is approximately $144 million for the next four years (from 1999 through 2002) through the submittal of the RWMC draft record of decision. These funds are necessary to fill the existing technical data gaps in accordance with the current regulatory schedule for the RWMC and to fulfill the requirements of the Pit 9 Record of Decision. Information generated by these activities will reduce the uncertainties in contaminant transport modeling and long-term risk assessment, and provide a complete analysis of technical solutions. Completion of the evaluation of risk to human health and the environment and careful analysis of candidate remedial technologies will ensure that appropriate cost-effective remediation alternatives are evaluated in the Waste Area Group 7 feasibility study.

The delay in the completion of the Pit 9 project has provided an opportunity to acquire additional data and consider emerging in situ technologies for application at the Subsurface Disposal Area. Options being explored include containment in place, in situ treatment, and retrieval followed by ex situ treatment. Combinations of remedial actions are being evaluated. Characterization and treatability studies are being conducted to determine how well specific contaminants of interest can be remediated. The information gained from the studies will allow evaluation of selective remediation of the Subsurface Disposal Area as a potential remedial alternative ensure that the final remediation techniques selected are the best available.

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ACRONYMS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
INEEL	Idaho National Engineering and Environmental Laboratory
RCRA	Resource Conservation and Recovery Act
RWMC	Radioactive Waste Management Complex

Remediation Plans for the Radioactive Waste Management Complex at the Idaho National Engineering and Environmental Laboratory

1. INTRODUCTION

The U.S. Senate report accompanying the *National Defense Authorization Act for Fiscal Year 1998* (S. Rep. No. 29, 105th Cong. 1st Sess. 428, 1997) contains a request that the U.S. Department of Energy (DOE) deliver to the congressional defense committees a report on remediation plans for the Radioactive Waste Management Complex (RWMC). This report is provided in response to the congressional request.

The RWMC is a DOE waste management facility located at the Idaho National Engineering and Environmental Laboratory (INEEL) as illustrated in Figure 1. The waste under investigation is buried in the Subsurface Disposal Area within the RWMC. Pit 9 is one of the disposal areas within the landfill. As identified in the congressional request, this report addresses four specific subject areas as follows:

- An analysis of proposed waste treatment options and disposal plans
- A determination of the threat of migration of radionuclides and any potential threat to groundwater
- An assessment of the suitability of a privatization program to treat waste at the site
- An assessment of the impacts of the Pit 9 project on plans to remediate the RWMC.

Brief discussions of the four specified issues are given below. Subsequent sections of the report provide additional detail and a broader understanding of the RWMC Subsurface Disposal Area, the ongoing investigation, and the cleanup options being evaluated.

The DOE Idaho Operations Office; the U.S. Environmental Protection Agency (EPA), Region 10; and the State of Idaho have collaborated to develop and implement a sound strategy to evaluate the potential risk posed by the buried waste at the RWMC and select appropriate remediation techniques. Substantial progress has been achieved. Continued implementation of the strategy will reduce the uncertainties in the risk assessment, provide a complete analysis of technical solutions, and support technically sound, cost effective, risk management decisions.

1.1 Proposed Waste Treatment Options and Disposal Plans

Multiple remedial alternatives for treatment and disposal of buried waste and contaminated soil at the RWMC are being evaluated. The DOE has been conducting multiple treatability studies since 1998, and those studies will continue through 2002. The studies include field application of in situ vitrification, in situ thermal desorption, in situ grouting, and five ex situ soil treatment technologies. The in situ technologies may allow treatment of the waste in place, exposing fewer workers to risk and decreasing remediation costs. The results of the evaluation will be documented in a feasibility study report and presented to the public in a proposed plan. Ultimately, representatives of the DOE Idaho Operations Office, EPA, and the State of Idaho will select remedial actions for the RWMC and document the selections in a record of decision. The current schedule calls for submittal of the draft record of decision in December 2002 followed by implementation of the selected remedial actions in 2003. Four general response actions are currently under consideration:

Idaho National Engineering and Environmental Laboratory

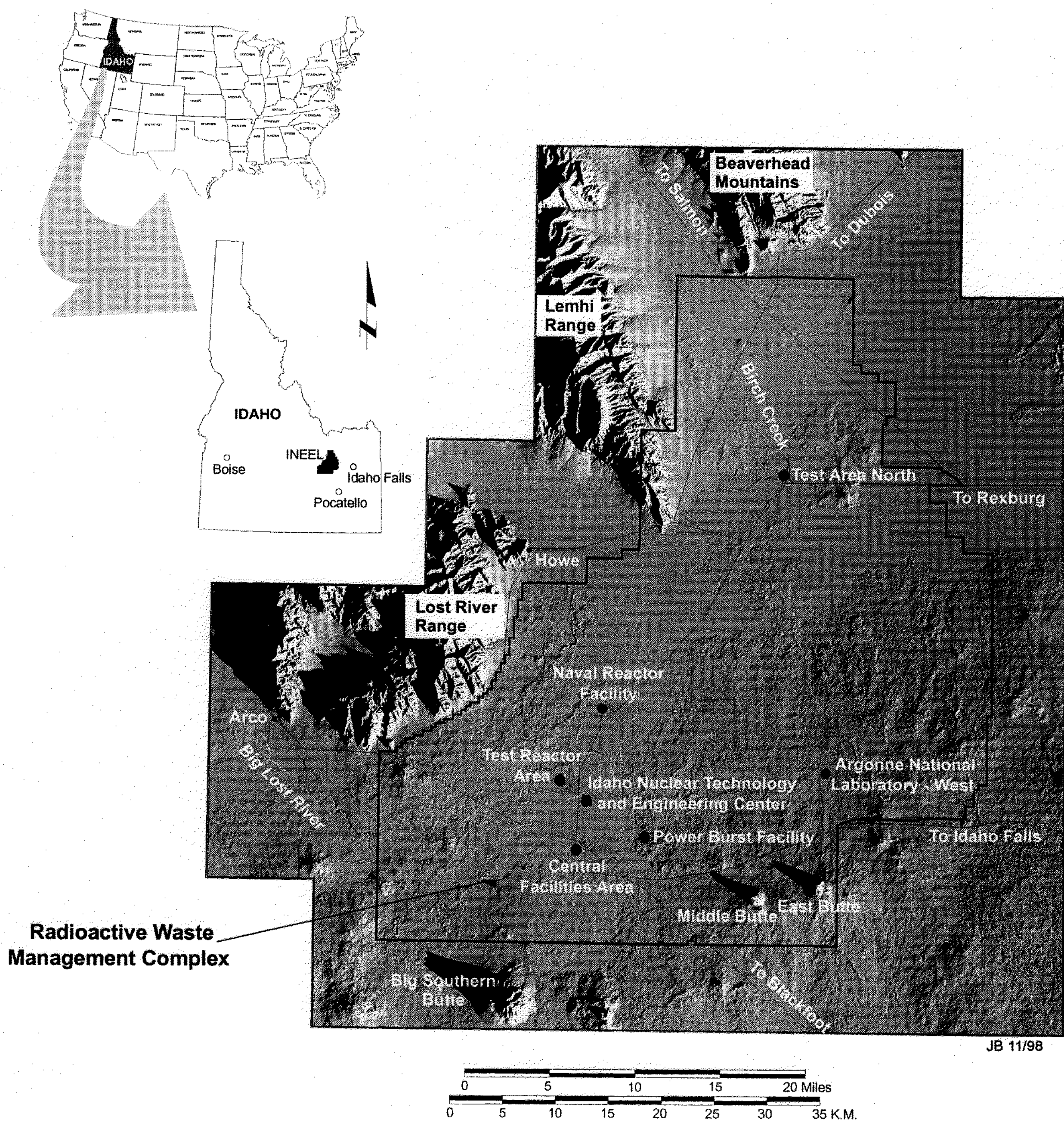

Figure 1. The location of the Radioactive Waste Management Complex at the Idaho National Engineering and Environmental Laboratory.

1. Institutional Controls—This response action includes instituting controls to restrict access and provide monitoring. The controls would be maintained to prevent or limit access to contaminated areas as long as DOE or another government agency maintains ownership or custodianship of the RWMC. Typically, a set period of time is defined. Restricted access may include administrative procedures, deed restrictions, fences or other barriers, signs, and security. Monitoring may include sampling the groundwater, air, and vadose zone. No active remediation is performed.

2. Containment—This response action includes methods that do not directly treat the waste but provide containment through the construction of a barrier to inhibit contact between the contaminated media and the surrounding environment. The bulk of the material in the landfill remains undisturbed. Barriers can be constructed to completely surround the waste, or can be limited to walls, floors, caps, or a combination designed to address site-specific remediation goals. Various natural and synthetic materials can be used. The risk posed by migration of and exposure to contaminants would be reduced without removing contaminated media from the site. A containment technology would inhibit erosion and reduce infiltration of moisture through contaminated media to the underlying aquifer.

3. In Situ Treatment—This response action includes reducing risk posed by chemical and radiological constituents by treating the contaminated media in place. In situ treatments can stabilize the waste to inhibit contaminant migration to the groundwater and reduce contact with the environment. The types of technology include physical, chemical, biological, and thermal treatments that destroy, remove, or stabilize contaminants. Examples include, but are not limited to, in situ vitrification, in situ grouting, in situ thermal desorption, and vapor vacuum extraction. In situ treatments can be used in series so that one technology is a pretreatment for another or as stand-alone solutions.

4. Retrieval, Ex Situ Treatment, and Disposal—Under this response action, contaminated soil and waste would be retrieved, treated, and disposed of. Standard and remote-controlled operations would be implemented to excavate the contaminated media. Waste and soil sorting would likely be required before treatment. Candidate ex situ treatments include, but are not limited to, physical, chemical, biological, and thermal methods.

In addition, a No Action alternative is being evaluated. Under the No Action alternative, the landfill would be left in its current state. Environmental monitoring would be conducted to identify changes in conditions at the site and provide information about contaminant migration. Though this action may not be protective of human health and the environment, it is evaluated to establish a baseline for assessing the effectiveness of other remedial alternatives as recommended in EPA guidance (EPA 1988).

The selected remedy for the buried waste and contaminated soil at the RWMC could be either a single alternative or a combination of remedial alternatives. Some waste buried in the landfill contains higher concentrations of contaminants than other waste. Therefore, specific areas within the landfill pose more risk than other areas. Selective remediation for specific high-risk areas in combination with less rigorous remediation of lower-risk areas may be appropriate to safely and efficiently manage the overall risk associated with the site.

1.2 Contaminant Migration and Potential Threats to Groundwater

Remedial options for the RWMC are being explored because monitoring data and risk projections indicate that contaminants migrating from the Subsurface Disposal Area threaten the quality of the underlying Snake River Plain Aquifer. The RWMC, including the 97-acre Subsurface Disposal Area landfill, lies approximately 600 feet above the Snake River Plain Aquifer. This aquifer has been designated by the EPA as a "sole source" aquifer (56 FR 50634), indicating its significance as a source of drinking water. The location of the INEEL relative to the Snake River Plain Aquifer is illustrated in Figure 2.

Though the congressional request specified a determination of the migration and threat to groundwater posed by radionuclides, volatile organic compounds present the most imminent potential human health risk associated with the waste buried at the RWMC. Therefore, an understanding of the volatile organic compounds is important. Volatile organic compounds have been detected in the aquifer in concentrations that exceed maximum contaminant levels for drinking water. The contamination has not been detected outside of the INEEL. However, risk simulations predict that the risk from volatile organic compounds, radionuclides, and other contaminants will continue to increase if migration from the landfill, through the subsurface, and to the aquifer is allowed to continue unabated. Other nonradioactive hazardous materials also are contained in the waste. The potential migration and threat to groundwater from all contaminants associated with the RWMC are summarized in the discussion below.

Volatile organic compounds have migrated from the buried waste and are ubiquitous in the local environment. Because these contaminants are not naturally occurring, any detected concentration is considered above an assumed background concentration of zero. Concentrations of carbon tetrachloride, chloroform, trichloroethylene, and other volatile organic compounds have been detected laterally in the subsurface more than 3,000 feet from the landfill boundary and vertically down to the aquifer at an approximate depth of 600 feet. Volatile organic compounds have been regularly detected in the aquifer at levels considerably greater than the assumed zero background concentrations. Carbon tetrachloride concentrations slightly above the maximum contaminant level for drinking water of 5 micrograms per liter have been detected, and the trend in measured carbon tetrachloride concentrations is generally increasing (Magnuson and Sondrup 1998).

Other contaminants, including radionuclides, have been detected in the unsaturated subsurface media and the underlying Snake River Plain Aquifer. The region above the aquifer, known as the vadose zone, consists of thin layers of sediment separated by thick layers of basalt. Occasionally, small ephemeral bodies of water, called perched water, collect above a sediment layer in the vadose zone. Contaminants that have been detected in the vadose zone media (i.e., sediment, soil moisture, and perched water) in concentrations exceeding background values include several radionuclides, metals, and nitrates. The presence of contaminants in concentrations exceeding background values indicates migration from the buried waste. Generally, concentrations diminish with depth and distance from the RWMC.

Though several inorganic contaminants have been detected in the aquifer in concentrations above background levels, the monitoring data vary widely and show no clear trend in concentrations. Tritium (hydrogen-3) is the only radionuclide consistently detected above regional background levels. Elemental metals such as antimony, beryllium, cadmium, chromium, lead, magnesium, manganese, mercury, nickel, and phosphorus also have been detected in the aquifer above background concentrations. Like the radionuclides, the metals are detected sporadically and clear trends are not evident. Nitrates are regularly detected above background levels and have exceeded the maximum contaminant level for drinking water of 10 milligrams per liter on at least nine occasions (Becker et al. 1998).

In an effort to quantify the potential threat to the aquifer, fate and transport modeling was conducted. The modeling attempted to predict future concentrations of contaminants in the aquifer (Magnuson and Sondrup 1998). The modeling simulated the No Action alternative, meaning that no mitigative measures were incorporated to reduce the risk potential. Aquifer concentrations in excess of maximum contaminant levels for drinking water or risk-based concentrations were predicted for several

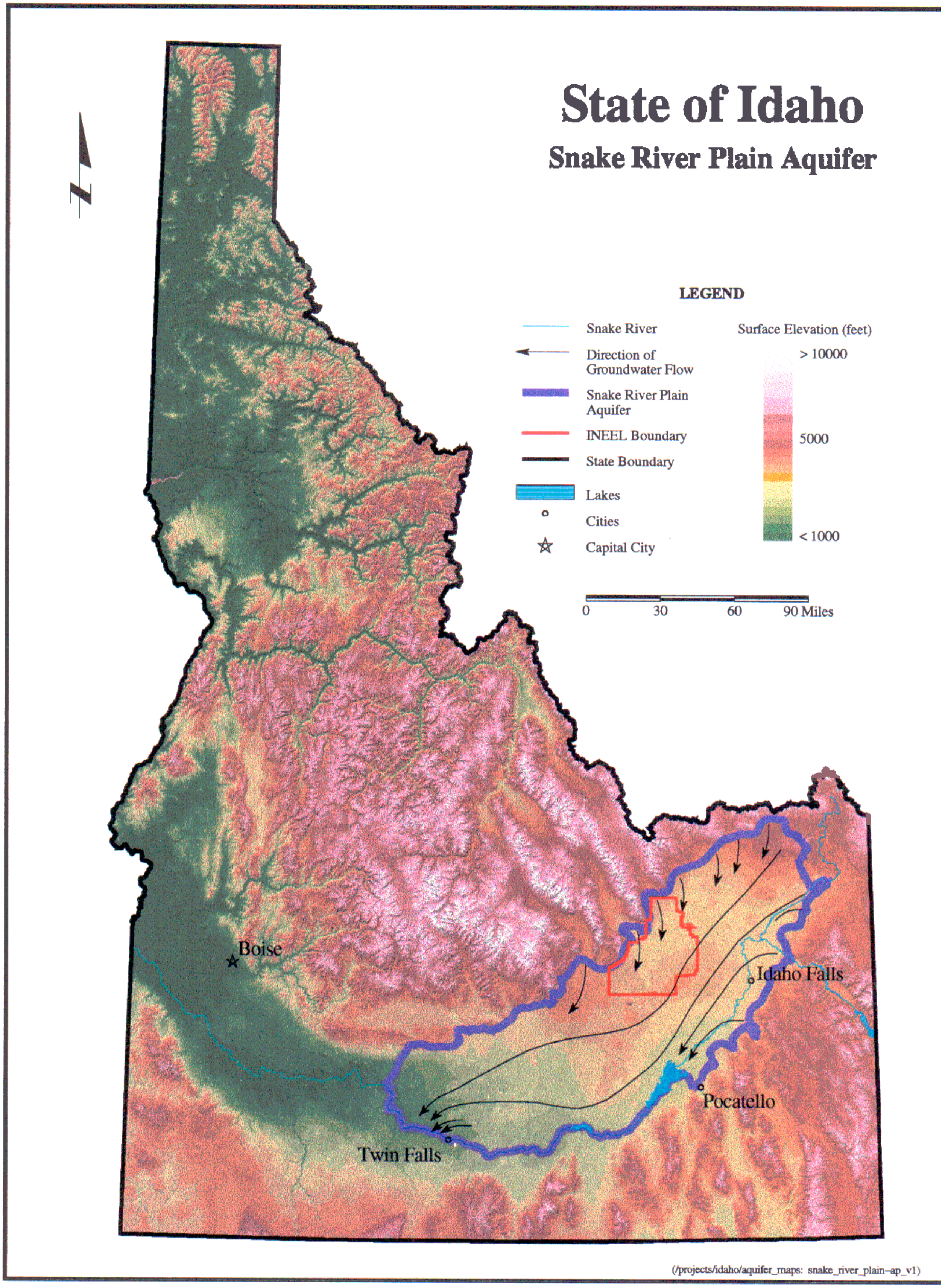

Figure 2. The location of the Idaho National Engineering and Environmental Laboratory relative to the Snake River Plain Aquifer.

contaminants. Based on this work, carbon tetrachloride poses the most immediate risk. Several radionuclides, nitrates, and toxic chemicals may pose future risks. Because the uncertainties associated with the modeling and predictive results are high, model refinement based on new data is being implemented to reduce the uncertainties associated with the simulations and allow quantification of the risk. Reliable risk estimates are not available because the investigation of the Subsurface Disposal Area is not complete.

1.3 Suitability of a Privatization Program to Treat Waste at the Subsurface Disposal Area

As an alternative to situations in which the management and operations contractor essentially performs the project with its own employees, DOE or the management and operations contractor can "privatize" a project by using private market mechanisms for the traditional government financed and owned facilities. Typically, payments to the private sector contractor or subcontractor are for delivered products (e.g., treated waste or services such as completing a permit or license application). Factors that should be used to evaluate the suitability of including a project in a privatization program are discussed in recently developed draft guidance titled "Program/Project Manager's Privatization Guide" (DOE 1998a). These factors are cost, mission, schedule, regulatory concerns, technology, procurement issues, vendor availability, risk, stakeholder input, and miscellaneous other concerns.

The potential for privatizing the treatment of the Subsurface Disposal Area cannot be fully evaluated at this time because the key to the correct application of privatization is a thorough understanding of the desired product or service. Until the final remedial solution is selected for the landfill, a recommendation on the applicability of privatization cannot be made; however, privatization of select remediation activities will be considered. A preliminary evaluation of the privatization potential is presented in Section 5.

1.4 Impacts of the Pit 9 Project on RWMC Remediation Plans

The Pit 9 project was established as an interim action and demonstration project intended to remediate Pit 9 and to provide information to assist in developing sound remedial decisions for the rest of the Subsurface Disposal Area. The INEEL management and operations contractor subcontracted for the services to be performed at Pit 9. The preliminary development of the comprehensive investigation of the RWMC was initiated in 1993 in parallel with the Pit 9 project. As originally planned, the Pit 9 project was to supply data to support the evaluation of risk and the assessment of remedial alternatives for the remainder of the buried waste. The Pit 9 project failed. The resulting delays have prevented the project from supplying data to support the comprehensive investigation of the RWMC as planned. The INEEL management and operations contractor terminated the Pit 9 subcontract and assumed responsibility for the Pit 9 project. Under the circumstances, it also was necessary to negotiate a revised approach for meeting the requirements of the Pit 9 Record of Decision (DOE-ID 1993) and the schedule for accomplishing this work. To allow the new approach to provide some data to support the comprehensive investigation of the RWMC, the schedule for the draft record of decision on the comprehensive investigation was revised from July 1998 to December 2002 (LMITCO 1997b).

The revised plan presently being implemented for Pit 9, called the Operable Unit 7-10 Staged Interim Action, defines a three-stage project. Stage I is a subsurface investigation; Stage II comprises limited excavation and an ex situ treatment technology demonstration; and Stage III is full-scale remediation of Pit 9. The Stage I and Stage II components will supply data and materials that could be used to support comprehensive investigation modeling and risk assessment activities and ex situ treatment technology tests. However, Stage II will not be completed until September 2003. Because the RWMC draft record of decision is scheduled for December 2002, most data from Stage II of the Pit 9 project will not be available to support the development of the comprehensive investigation and record of decision.

In summary, the Pit 9 project has had major impacts on remediation plans for the RWMC. The schedule for the record of decision for comprehensive investigation has been delayed approximately four and a half years. The comprehensive investigation must acquire data for risk assessment and evaluate ex situ treatment alternatives independent of Pit 9 because these data have not been supplied from the Pit 9 project as had originally been planned. However, the delay in the completion of the Pit 9 project provides an opportunity to acquire additional data and consider emerging in situ technologies for application at the Subsurface Disposal Area.

2. BACKGROUND

A brief history of waste disposal at the RWMC, the regulatory framework for evaluation of the site, and the investigation of the RWMC under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (42 USC § 9601 et seq.) are summarized below.

2.1 History of Waste Disposal at the RWMC

The RWMC, located in the southwestern quadrant of the INEEL, encompasses a total of 175 acres and is divided into three separate areas by function: the Subsurface Disposal Area, the Transuranic Storage Area, and the Administrative and Operations Area. The original facility was established in 1952 and covered 13 acres used for shallow burial of solid radioactive waste. In 1958, the Subsurface Disposal Area was expanded to 88 acres. Relocation of the security fence in 1988 to the outside of the dike surrounding the landfill established the current 97-acre size of the Subsurface Disposal Area. The Transuranic Storage Area was added to the RWMC in 1970. The Transuranic Storage Area is a retrievable waste examination and storage area encompassing 56 acres and contains waste stored above ground. The 22-acre Administrative and Operations Area includes administrative offices, maintenance buildings, equipment storage, and miscellaneous support facilities. Figure 3 illustrates the general layout of the RWMC.

2.1.1 Landfill Operations

The RWMC is a DOE waste management facility. Past and present operations at the RWMC include both temporary waste storage and permanent burial of waste. Disposal of weapons production waste from the Rocky Flats Plant in Colorado, nuclear reactor testing waste from the INEEL, a variety of waste from Department of Defense installations, and waste from various other generators approved by the predecessors of the DOE began at the RWMC in 1952. In addition to radioactive elements, nonradioactive hazardous materials such as volatile organic compounds, mercury, beryllium, asbestos, zirconium fines, solidified acids and bases, solvents and degreasing agents, and sodium and potassium

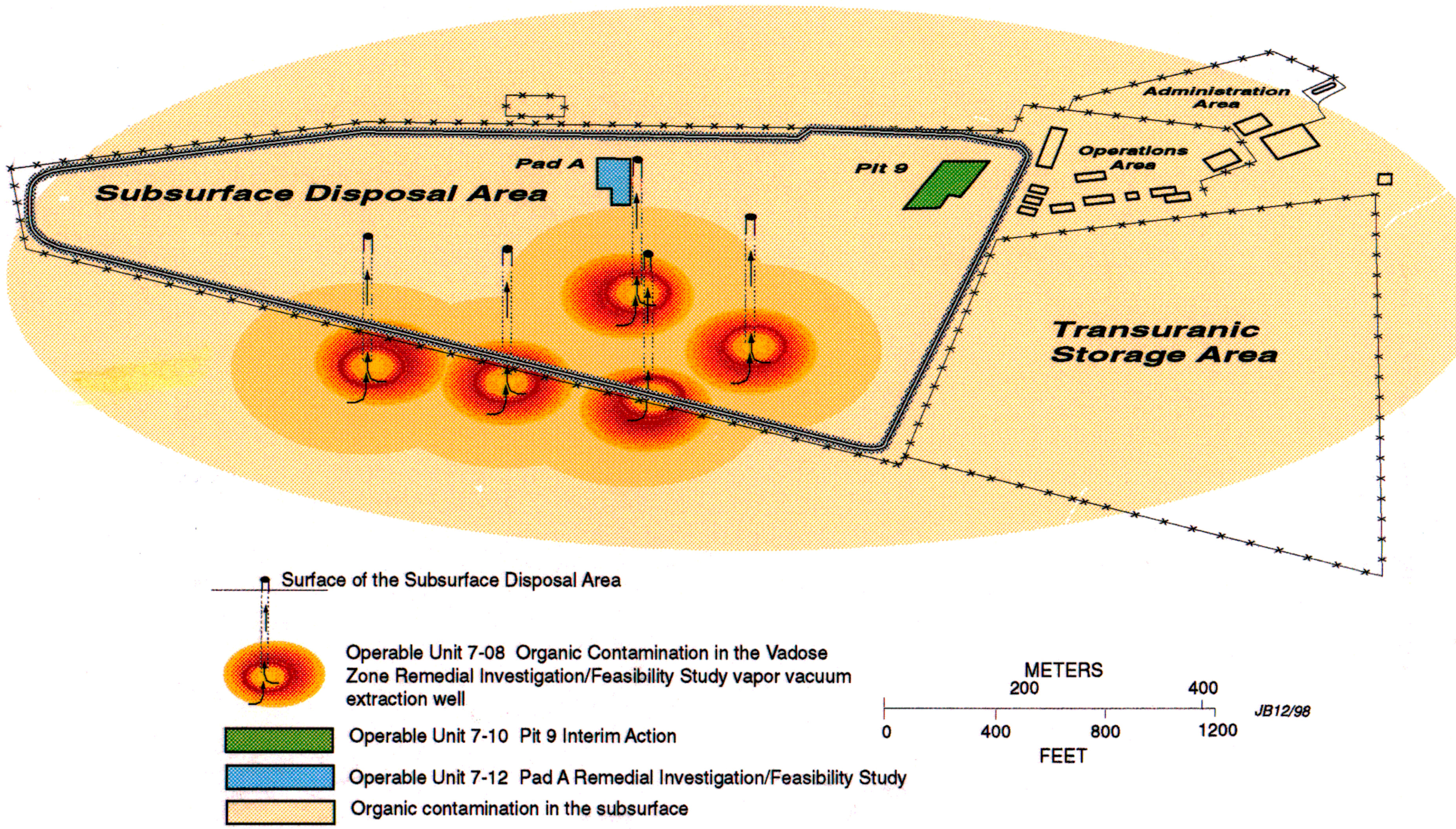

Figure 3. Physical layout of the Radioactive Waste Management Complex.

salts are contained in the waste. Permanent burial of transuranic waste[a] from Rocky Flats was discontinued in 1969. The RWMC continues to operate a portion of the Subsurface Disposal Area as a low-level radioactive waste landfill for INEEL waste.

Waste is buried by excavating or drilling through the surface soil down to the underlying bedrock. Depth to bedrock (i.e., the thickness of the surface soil) ranges from 2 to 23 feet within the landfill. Waste is buried in trenches, pits, and soil vaults. Trenches are long excavations with a minimum width of 7 feet. Because trench widths do not accommodate large items, broad pits were excavated for the disposal of bulky waste and large waste shipments. Rows of soil vaults, which are rows of separate round holes ranging in diameter from 2 to 6 feet, are used for the disposal of low-level waste with high radiation exposure rates.

Some areas of the RWMC are unsuitable for waste burial because the bedrock is too shallow. Therefore, the layout of the disposal areas in the landfill is highly irregular, as illustrated in Figure 4. In one area of shallow surface soil, an asphalt pad, called Pad A, was constructed. Drums and boxes of waste were placed on the pad and covered with soil. In total, 20 pits, 58 trenches, and 21 soil vault rows have been constructed. Waste disposals from 1952 to 1969 occurred in Pits 1 through 10 and Trenches 1 through 51. Pad A was not used until 1972, and soil vault disposal began in 1977. Much of the waste in Pits 2, 4, 6, 9, and 10 was originally generated by Rocky Flats weapons production operations. Rocky Flats waste received since 1970 has been placed in aboveground retrievable storage at the Transuranic Storage Area.

2.1.2 Interim Waste Storage Operations

The Transuranic Storage Area was constructed in 1970 to provide interim storage of retrievable waste. Operations include waste segregation, examination, and certification in addition to interim storage. Though the Transuranic Storage Area is within the area defined for CERCLA evaluation, the facility is operated under a Resource Conservation and Recovery Act (RCRA) (42 USC § 6901 et seq.) permit and will eventually be closed in accordance with RCRA requirements. Ultimately, all of the stored waste will be removed from Idaho. Therefore, the Transuranic Storage Area is not a likely source of unacceptable risk. However, residual environmental contamination such as contaminated soil will be assessed under CERCLA in conjunction with the RCRA closure of the facility.

2.2 Regulatory Framework

The EPA added the INEEL to the National Priorities List on November 21, 1989 (54 FR 48184). The DOE Idaho Operations Office, EPA, and the State of Idaho entered into the INEEL Federal Facilities Agreement and Consent Order on December 9, 1991 (DOE-ID 1991). The buried waste at the RWMC is a component of the INEEL Superfund site, and remediation of the buried waste is being evaluated under CERCLA. The Federal Facilities Agreement and Consent Order defines the framework for conducting these CERCLA evaluations. The CERCLA process at the INEEL includes cooperative decision-making

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a. Transuranic waste was generally defined as waste containing concentrations greater than 10 nanocuries per gram of long-lived radioactive elements with an atomic number greater than uranium's 92 (e.g., plutonium, americium, and neptunium). The definition of transuranic waste was revised in 1982 to materials containing any alpha-emitting radionuclide with an atomic number greater than 92, a half-life longer than 20 years, and a concentration greater than 100 nanocuries per gram at the end of institutional control.

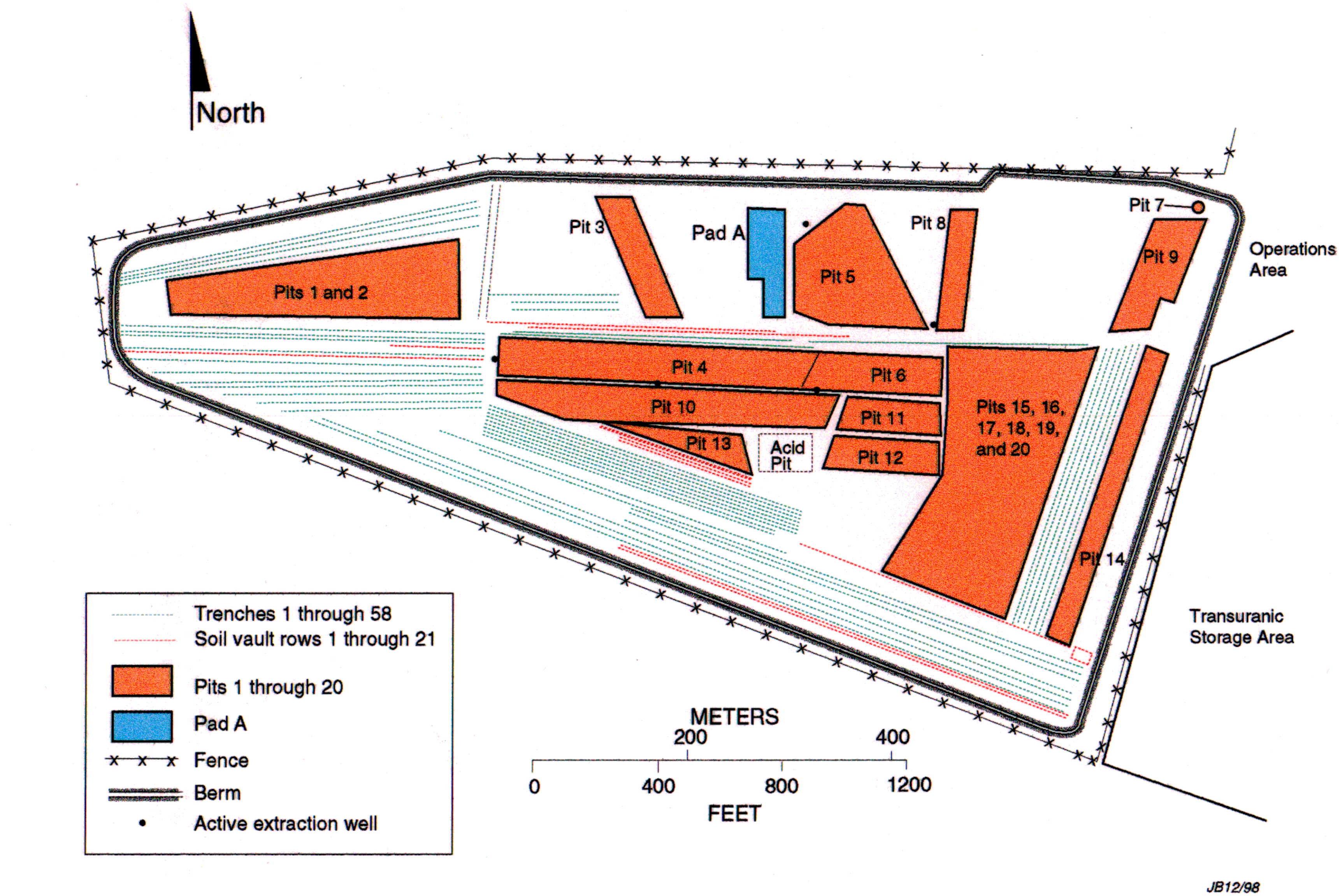

Figure 4. Layout of the Subsurface Disposal Area.

between the DOE Idaho Operations Office, EPA, and the State of Idaho with public participation through a citizen's advisory board, public meetings, and formal comment periods.

The Federal Facilities Agreement and Consent Order designates the RWMC area as Waste Area Group (WAG) 7, which is further broken down to 14 operable units. The Action Plan attached to the Federal Facilities Agreement and Consent Order established the schedule for remedial decisions for the INEEL, including Waste Area Group 7. To allow required technical information to be obtained to support the decision-making process, the schedule for the draft record of decision on Waste Area Group 7 was later revised by the DOE Idaho Operations Office, EPA, and the State of Idaho from July 1998 to December 2002 in accordance with the March 17, 1997, *Agreement to Resolve Disputes* (Jensen 1997).

2.3 Investigation of the RWMC Under CERCLA

The CERCLA investigation of the RWMC follows the evaluation process outlined in the Action Plan attached to the Federal Facilities Agreement and Consent Order (DOE-ID 1991). First, each operable unit is assessed in accordance with requirements and the appropriate remedial actions are identified through a formal decision-making process. The decision-making process is initiated with a proposed plan that summarizes the possible remedial alternatives and identifies preferred alternatives. The proposed plan is distributed to stakeholders. Public meetings are held to answer questions and solicit written and verbal comments on the proposed plan. After public opinion is considered, a legally binding record of decision that specifies the remedial action is signed by the DOE Idaho Operations Office, EPA, and the State of Idaho pursuant to the Federal Facilities Agreement and Consent Order. Following remediation, operable units with contamination left in place are subject to review every five years under CERCLA.

A significant amount of work has been completed on Waste Area Group 7 to date, and additional efforts are continuing in support of the comprehensive investigation. Records of decision have been completed for three operable units, and the investigation to support the final comprehensive record of decision is in progress. The Record of Decision for Operable Unit 7-08 (Organic Contamination in the Vadose Zone) (DOE-ID 1994a) was signed in November 1994, and the selected remedy has been successfully implemented. The Record of Decision for Operable Unit 7-12 (Pad A) (DOE-ID 1994b) was signed in January 1994, and the selected remedy was successfully completed in November 1994. The implementation of the Pit 9 Record of Decision (DOE-ID 1993) is continuing as described in the revised scope of work for the Pit 9 interim action (LMITCO 1997a) and summarized below. The other tasks defined to support the comprehensive investigation for Waste Area Group 7 continue as described in this report. Evaluation of other operable units in Waste Area Group 7 will be completed in conjunction with the overall comprehensive record of decision for all sites in Waste Area Group 7. The comprehensive record of decision will be the next and final record of decision for Waste Area Group 7.

2.3.1 Organic Contamination in the Vadose Zone

A remedial investigation/feasibility study was implemented to estimate the extent of organic contamination in the vadose zone and identify appropriate remedial actions. Volatile organic compounds, primarily carbon tetrachloride vapor, have migrated from Rocky Flats waste buried in the Subsurface Disposal Area, permeated the vadose zone and reached the underlying Snake River Plain Aquifer. Concentrations in excess of maximum contaminant levels for drinking water have not been detected outside of the boundaries of the INEEL. However, carbon tetrachloride concentrations slightly above the maximum contaminant level for drinking water of 5 micrograms per liter have been detected in the aquifer near the RWMC. Monitoring over time indicates that the level of contamination is slowly increasing. Transport modeling indicated that state and federal drinking water standards could be exceeded in the future for trichloroethylene, tetrachloroethylene, and carbon tetrachloride if unabated contaminant migration is allowed to continue. Therefore, the Operable Unit 7-08 Record of Decision (DOE-ID 1994a) defined a remedial action to remove organic contamination from the vadose zone and reduce contaminant migration to the aquifer.

Three two-year phases to extract vapor from the upper 110-foot interval beneath the Subsurface Disposal Area are being implemented. At the end of each phase, the effectiveness of the extraction system is evaluated to determine whether the remedial action adequately addresses the threat to the aquifer from organic contamination in the vadose zone. If warranted, additional extraction wells or some other enhancement to the remedial action could be selected. The first phase began with the installation of five extraction wells, shown in Figure 3, and three catalytic oxidation treatment units to destroy the volatile organic compounds. The system began operating in January 1996 and the first phase ended in January 1998. The subsequent evaluation showed that the current system is effectively removing contaminant mass from the vadose zone. To date, the system has removed and treated more than 53,000 pounds of volatile organic compounds, including 34,477 pounds of carbon tetrachloride, from the vadose zone beneath the RWMC. Because of this success, operations initiated in the first phase are continuing without modification through the second phase. Removing vapors from the subsurface does not mitigate the source of the contamination. The potential threat to the aquifer from volatile organic compounds requires evaluation of remedial alternatives to address the source still contained in the buried waste. Source treatment could be required in conjunction with the vapor vacuum extraction conducted for Operable Unit 7-08. As discussed below, the Operable Unit 7-10 Staged Interim Action will address the organic contaminants buried in Pit 9. Remedial alternatives will be evaluated in the comprehensive investigation for Waste Area Group 7 for volatile organic compounds remaining in other parts of the Subsurface Disposal Area.

2.3.2 Pit 9 Interim Action

The Pit 9 project was established as an interim action and a demonstration project to remediate Pit 9, provide information on the Subsurface Disposal Area, and supply information about excavation and treatment alternatives to assist in making a sound remedial decision for the RWMC (Waste Area Group 7). The Pit 9 Record of Decision (DOE-ID 1993) specified an interim action consisting of excavation of the waste, chemical and physical separation of the waste, and waste treatment to destroy contaminants and reduce volume. Performance of this interim action would demonstrate techniques that could be used to remedy other mixed waste burial grounds. As discussed in Section 1.4 above, the subcontract was terminated. Enforceable agreement milestones have been missed, and data planned to support the Waste Area Group 7 comprehensive investigation are incomplete or unavailable. As a result of missing enforceable Federal Facility Agreement and Consent Order (DOE-ID 1991) milestones associated with Pit 9, DOE paid $940,000 in stipulated penalties: $100,000 to the EPA and $840,000 to a State of Idaho trust fund to be used for a future environmental improvement project.

2.3.2.1 Revised Strategy to Complete the Pit 9 Interim Action. Because the subcontract for the implementation of the Pit 9 interim action was terminated and the regulatory agencies are requiring DOE to meet the requirements of the Pit 9 Record of Decision (DOE-ID 1993), the development of a revised schedule and scope of work (LMITCO 1997a) were necessary to satisfy the requirements of the Pit 9 Record of Decision. A three-stage process for remediating Pit 9 was jointly developed by the DOE Idaho Operations Office, EPA, and the State of Idaho, and the schedule for completing the comprehensive investigation of the RWMC was extended. The revised effort, referred to as the Operable Unit 7-10 Staged Interim Action, will remediate Pit 9 and provide information that could support the comprehensive investigation of Waste Area Group 7, though most of the information developed in completing the work required by the Pit 9 Record of Decision will not be available in time to support the comprehensive feasibility study as originally intended.

The Operable Unit 7-10 Staged Interim Action will include three stages: Stage I, November 1997 to September 2000, focuses on subsurface exploration. Stage II, March 1998 to September 2003, focuses on design, construction, and operation of robotic and remotely operated retrieval systems and confinement systems to retrieve waste and soil safely from Pit 9 and demonstrate the ability to achieve the remedial action objectives of the Pit 9 Record of Decision (DOE-ID 1993). Stage III, October 2000 to September 2004, will complete the remediation of Pit 9. If Stage II goals are not met, the Stage III full-scale remediation will not proceed and the Pit 9 interim action will be addressed in an explanation of significant differences, in an amendment to the Pit 9 Record of Decision or in the comprehensive investigation for Waste Area Group 7.

2.3.3 Pad A

Operable Unit 7-12 represents Pad A (see Figure 4), an asphalt pad constructed within the Subsurface Disposal Area in an area unsuitable for subsurface disposal because the surface sediments are too shallow. Pad A was open from 1972 to 1978 for the disposal of packaged low-level waste from Rocky Flats. Boxes were stacked around the periphery of Pad A, and drums were stacked horizontally in staggered layers and covered with soil. The pad and the waste were covered with a final contoured soil layer and seeded with grass. According to disposal records, waste on Pad A is composed primarily of nitrate salts, depleted uranium waste, and sewage sludge. The bulk of the waste on Pad A, more than 18,000 drums and 2,000 boxes, contains very low concentrations of transuranic contaminants.

An investigation was implemented to assess risk and identify appropriate remedial alternatives for Pad A. Transport modeling identified a potential future risk from the ingestion of nitrate-contaminated groundwater. The remedial action selected in the Pad A Record of Decision (DOE-ID 1994b) was a limited action consisting of repairing subsidence of the existing soil cover, correcting the soil cover slope, seeding bare spots with vegetation, maintaining the soil and vegetation cover, and installing environmental monitoring equipment to verify the effectiveness of the remedial action. The remedial action was completed in 1995.

2.3.4 Comprehensive Investigation

The comprehensive investigation of Operable Unit 7-13/14 will evaluate the cumulative risk associated with Waste Area Group 7. Though Waste Area Group 7 includes all areas of the RWMC (i.e., the Subsurface Disposal Area, the Transuranic Storage Area, and the Administrative and Operations Area as shown in Figure 3, and all operable units identified for evaluation), the buried waste will be the general focus of the comprehensive study. The Administrative and Operations Area does not contain any historical sources that may generate risk. The Transuranic Storage Area is an active storage facility. When the facility is closed, appropriate measures will be implemented to satisfy the requirements of both RCRA (42 USC § 6901 et seq.) and CERCLA (42 USC § 9601 et seq.). These requirements include clean closure of the aboveground structures and a risk-based closure of any contaminated subsurface areas. The primary threat to environmental media such as the aquifer results from contaminant migration from the buried waste. Therefore, future remedial alternatives will focus on buried waste and contaminants that contribute most of the risk. The schedule for the draft record of decision for the comprehensive study is December 2002.

3. PROPOSED WASTE SITE TREATMENT OPTIONS AND DISPOSAL PLANS

The general response actions that will be considered to mitigate the risks associated with the Subsurface Disposal Area include No Action, Institutional Controls, Containment, In Situ Treatment, and Ex Situ Treatment. The No Action alternative will be prepared as a baseline for comparison of other alternatives.

Because of its complexity, more than one general response action will likely be taken at the Subsurface Disposal Area. The response actions may either be separate actions for specific areas within the landfill or in series to provide adequate protectiveness and a cost-effective solution.

The remedial alternatives will be evaluated in the feasibility study, but the alternatives that will be implemented at the RWMC will not be determined until the Waste Area Group 7 record of decision is developed. For planning purposes, the baseline budget projection of $1.9 billion for the Subsurface Disposal Area assessment and remediation is based on a hypothetical combination of response actions including retrieval and ex situ treatment of contaminated media from Pits 1, 2, 3, 4, 5, 6, 9 and 10 (see Figure 4); a containment barrier capping the entire Subsurface Disposal Area; and institutional controls and monitoring for 30 years. The current budget projection and the feasibility study to evaluate remedial alternatives for Waste Area Group 7 incorporate the following assumptions:

- Additional remediation of Operable Unit 7-12 (Pad A) will not be required. (The recently completed interim risk assessment [Becker et al. 1998] indicates that nitrates, almost half of which are stored on Pad A, may present an unacceptable risk. Evaluation of nitrates and perched water data may lead to further action at Pad A. The five-year reviews of the effectiveness of the Pad A remedy could determine that further actions are required.)

- Remediation of groundwater will not be required. It is assumed for planning purposes that remediation of the waste buried in the Subsurface Disposal Area will sufficiently mitigate future groundwater risk and that current groundwater risk is mitigated through institutional controls and the Operable Unit 7-08 (Organic Contamination in the Vadose Zone Remedial Investigation/Feasibility Study) remediation.

- Remediation of the Transuranic Storage Area will not be required. The RCRA closure of the facility will address the residual risk potential after the Transuranic Storage Area facilities are closed. At most, some Transuranic Storage Area soil may require remediation under CERCLA. Contaminated soils from the Transuranic Storage Area can be consolidated in the Subsurface Disposal Area for remediation and the containment barrier will not cover the Transuranic Storage Area.

- Remediation of Pit 9 will be successfully completed under the Operable Unit 7-10 Staged Interim Action (see Section 2.3.2.2).

3.1 Institutional Controls

Institutional controls are usually a component of any remedial action with contaminated media remaining onsite. Institutional controls include but are not limited to monitoring; access restrictions such as fences, signs, and security-enforced access controls; site maintenance such as subsidence repair and runoff controls; and land-use restrictions. The controls essentially maintain the current level of protection. Environmental monitoring would be conducted to identify changes in conditions at the site and provide information about contaminant migration. Generally, institutional controls are easily implemented. However, the results of the interim risk assessment (Becker et al. 1998) indicate that institutional controls would not be adequate to mitigate the risks to human health and the environment associated with the Subsurface Disposal Area

3.2 Containment

Containment can be used as a stand-alone mitigation to inhibit contact between the contaminated media and the surrounding environment, in combination with other techniques such as in situ or ex situ treatment, or as an intermediate action until full remediation can be accomplished. Containment barriers such as walls, floors, and caps can be composed of various types of materials. Numerous vendors can supply containment techniques. Techniques include bottom sealing using horizontal or directional drilling; in situ vitrification planar melts; caps; walls composed of polymers, slurry, or other appropriate material; and cryogenic barriers. Several innovative cap designs are under assessment at the INEEL and other DOE facilities.

The two general types of vertical and horizontal barrier systems are impermeable and permeable barriers. Impermeable barriers focus on controlling the movement of contaminants by restricting or eliminating the flow of contaminated liquids and vapors from the waste site. Common materials used for impermeable barriers include various cement types, bentonite and soil mixtures, geomembranes, and sheet piling. Less common impermeable barrier materials include sodium silicate, epoxy, styrene, montan wax, and acrylate. Cryogenic barriers and in situ vitrified melts also are impermeable. Permeable barriers, by contrast, rely on chemical or biological reactions of the barrier material with contaminants to inhibit migration. Contaminants migrate to the barrier media with the groundwater or soil gas. Upon contact, a chemical or biological reaction is initiated that immobilizes or destroys contaminants.

Barriers also can be designed to exploit specific properties of both permeable and impermeable materials. Materials that can control the permeability of a site also can have a reactive nature to enhance overall performance with certain contaminants. Examples of barrier materials that possess both properties include cements, certain phosphates, iron oxides, and zeolite.

Surface barriers (i.e., caps) are directly applicable to the landfill and will likely be a component of the overall remediation strategy. A well-designed cap can significantly reduce water infiltration, reduce biotic intrusion (i.e., intrusion by burrowing animals and deep-rooting plants), and control erosion to reduce contaminant migration and inhibit biotic uptake.

The primary concerns at the RWMC are downward movement of contaminants to the underlying Snake River Plain Aquifer and the lateral spread of volatile organic compounds away from the RWMC. Vapor vacuum extraction is successfully being employed to remediate the volatile organic compounds in the subsurface (see Section 2.3.1). Therefore, vertical barrier technology, which is designed to inhibit lateral migration, is not a likely candidate remedial alternative to contain the organic vapors in the landfill.

Bottom barriers are not directly applicable to the RWMC because of the large size of the site and the difficulties introduced by the underlying fractured basalt. Technology advances may support implementation of bottom barriers in the future.

3.3 In Situ Treatment

In situ treatment reduces risk posed by chemical and radiological constituents by treating the contaminated media in place. In situ treatments can stabilize the waste to inhibit contaminant migration to the groundwater and reduce contact with the environment. Technology types include physical or chemical; biological; solidification, stabilization, or a combination of both; and thermal treatments that destroy, remove, or stabilize contaminants. Examples include, but are not limited to, in situ vitrification, in situ grouting, in situ thermal desorption, and vapor vacuum extraction. In situ treatments can be used in series so that one technology is a pretreatment for another. Others can be used as stand-alone solutions.

Physical or chemical treatment involves manipulation of waste in place to reduce toxicity, mobility, or volume. In situ physical or chemical treatments at the Subsurface Disposal Area could be used on soils, sludges, gases, and sediments. Examples of in situ physical or chemical treatments include dechlorination, electroacoustics, electrokinetics, neutralization, oxidation/reduction, precipitation/flocculation, soil flushing/washing, steam/air stripping, and vacuum extraction.

In situ biological treatments exploit the natural activity of microorganisms, primarily bacteria, actinomycetes, or fungi, to remediate polluted soils. While biological treatments require a longer period for remediation than other treatment alternatives, they have the potential to completely destroy organic contaminants. Bioremediation also can be used as a means to decrease metal and radionuclide contaminant mobility.

In situ solidification and stabilization are treatment processes designed to accomplish one or more of the following: (1) improve handling and physical characteristics of the waste by producing a solid, (2) reduce contaminant solubility in the treated waste, and (3) decrease the exposed surface area across which transfer or loss of contaminants may occur (EPA 1990). Solidification techniques eliminate free liquid, increase the bearing strength, decrease the surface area of the waste material, and produce a monolithic solid product of high structural integrity. Solidification may involve encapsulation of fine waste particles (microencapsulation) or large blocks of waste (macroencapsulation). Chemical interactions do not necessarily occur between the waste and the solidifying agents, but the waste material is mechanically bound within the solidified matrix in such a way that the release rate of hazardous substances is significantly decreased upon exposure to air, water, soil, or mild acidic conditions (EPA 1990). Stabilization techniques reduce risk by converting the contaminants into their least soluble, mobile, or toxic form. This technique does not necessarily change the physical characteristics of the waste (EPA 1990). Solidification and stabilization reduce contaminant mobility, increase the volume, and only incidentally effect toxicity.

In situ thermal treatments sufficiently elevate the temperature of the contaminated media to volatilize (i.e., convert to vapor form) many contaminants such as carbon tetrachloride and other organic compounds, polychlorinated biphenyls, aromatics, and some inorganic compounds and metals. Some techniques also can alter the mobility of the waste. Examples of thermal treatments include in situ vitrification, in situ thermal desorption, steam stripping, vapor vacuum extraction, six-phase soil heating, in situ corona, and radiofrequency ground heating. In situ organic removal requires a method of in situ heating along with a controlled organic extraction and destruction method. The volatilized contaminants are captured in an off-gas collection system at the surface, thereby reducing the toxicity of the buried waste and soil.

In situ vitrification works by melting soil and waste in place using electricity applied between pairs of graphite electrodes that are inserted in a square or rectangular configuration. After the soil and waste are melted and the electricity is turned off, the material cools to a solid glass monolith. Nonvolatile metals and radionuclides are chemically incorporated as oxides into the vitrified product. Volatile metals such as mercury are vaporized and removed by the off-gas treatment system. Organic contaminants are typically destroyed in the ground and the by-products migrate to the surface where they are oxidized in an off-gas hood. Vapors from the off-gas hood are then treated before being discharged to the atmosphere. The highly reducing nature of the in situ vitrification melt may cause some metals (e.g., iron) to settle to the bottom of the melt as a separate phase (Buelt et al. 1987). Vitrification of high-level waste has demonstrated that some radionuclides, such as uranium and plutonium, will not be reduced and will remain in the glass phase because of their high oxidation potentials (Buelt et al. 1987). In situ vitrification treatability tests and large-scale demonstrations on soils contaminated with uranium and plutonium (Thompson and Costello 1996) have confirmed this conclusion. In situ vitrification produces a vitreous rock-like material that is free of organic material and has a compressive strength approximately 10 times that of unreinforced concrete. The vitrified product is extremely leach-resistant and typically will pass even the most stringent leach tests. The durability of the vitrified product is probably similar to naturally occurring obsidian, which has a life expectancy measured in millions of years when exposed to the natural environment (Buelt et al 1987).

In situ thermal desorption uses electrical resistance heating elements (Iben et al. 1996). Heat is applied through rods in wells (thermal well systems) (Hanke 1997) for applications such as the RWMC. The treatment temperatures of the soil and waste range from 600 to 1,000°C, depending on the target contaminants. The temperature is controlled by the voltage applied to the heating elements and the length of time that the soil and waste are heated. In situ thermal desorption will destroy volatile organic compounds, volatilize most of the mercury and some of the cesium, and may chemically stabilize plutonium and other radionuclides and metals. The high-temperature in situ thermal desorption process is applicable for tritium, carbon-14, resins, heavy oils, and chelating agents and can apparently handle some types of debris in addition to soil. A number of nonorganic wastes also would be destroyed by the in situ thermal desorption temperatures, particularly nitrate and sulfate salts containerized in steel drums. The acidic off-gas is highly corrosive and could be difficult to manage.

Some in situ treatments are directly applicable to remediation of the Subsurface Disposal Area. Others, like bioremediation and in situ chemical processes, are not applicable to the Subsurface Disposal Area because of the heterogeneity of the buried waste forms (e.g., drums, boxes, large pieces of metal, and debris). Further advances of these technologies would be necessary before they can be considered. In situ solidification, in situ thermal desorption, and in situ vitrification are sufficiently robust that the heterogeneous waste forms do not significantly impact the technology performance.

3.4 Ex Situ Treatment

Under this response action, contaminated soil and waste would be retrieved, treated, and disposed of in accordance with regulations. Standard and remote-controlled operations would be implemented to excavate the contaminated media in conjunction with various contamination control techniques. Waste and soil sorting would likely be required prior to treatment.

Ex situ treatments can be divided into several categories, including thermal, physical, chemical, and biological methodologies and stabilization techniques. Thermal treatment can be classified as either high-temperature or low-temperature. The ex situ thermal treatment of buried wastes involves numerous technologies that are relatively well developed. In general, these high-temperature thermal treatment technologies are used to either convert the waste into a highly durable form ready for final disposal, as with vitrification technologies, or as a pretreatment for destroying certain components in the waste prior to stabilizing them in a durable waste form, as with incineration. Examples of high-temperature thermal treatment include the following:

- Joule-heated electric melters
- Carbon and plasma arc melters
- Plasma torch melters
- Incinerators
- Molten salt oxidation
- Vitrification.

Several low-temperature thermal treatment technologies could be applicable for treating volatile organic and inorganic contaminants, such as iodine-129, carbon tetrachloride, and methylene chloride. These potential low-temperature treatments include thermal desorption, supercritical water oxidation, and steam reforming.

Physical treatments consist of technologies that change the dimensions or volume of the waste such as sizing, compaction, and separation systems. Chemical treatments consist of technologies that alter the composition of the waste through neutralization, oxidation/reduction, precipitation, or other chemical means. Biological treatments can be aerobic or anaerobic (i.e., with or without oxygen) and use microorganisms to degrade, mineralize, mobilize, immobilize, extract, or otherwise transform hazardous substances into innocuous materials. Finally, stabilization technologies reduce the hazardous potential of waste material by converting the contaminants into their least soluble, mobile, or toxic forms.

Many of the suggested ex situ treatment technologies are applicable to at least a portion of the waste at the Subsurface Disposal Area. Separation technologies are directly applicable to the landfill to segregate the waste into manageable waste streams. The final disposal of the contaminants will significantly impact the applicability of the treatment technologies. Waste acceptance criteria of the disposal facilities will establish processing requirements. Once separation of the waste to the desired degree is achieved, treatment can be conducted in a controlled environment that enhances the applicability of the ex situ treatment technologies. Chemical and biological techniques that would not be applicable in situ could be implemented ex situ because the processing conditions can be controlled. Issues that are being investigated to further evaluate the applicability of ex situ treatments include the waste form requirements as determined by the waste acceptance criteria of candidate disposal facilities and effectiveness relative to processing efficiencies and secondary waste management requirements.

3.5 Retrieved Waste Disposal Options

The remedial alternatives being considered include retrieval and treatment of some of the contaminated media for final disposal in an approved facility off the INEEL site. The discussions below focus on the disposition of any waste that is removed from the Subsurface Disposal Area for final disposal at DOE facilities outside of the INEEL. At this time, the quantities of various types of waste that would be considered for disposal outside of the INEEL and costs for those disposals are unknown.

Potential issues associated with shipping waste outside of the INEEL include compliance with waste acceptance criteria and other issues. These issues must be resolved before the waste is ready for shipment, or an alternative disposal strategy must be developed. The remediation of Waste Area Group 7 is scheduled to begin in 2003 after the record of decision has been finalized. In the meantime, waste acceptance criteria for existing and newly available disposal facilities will be monitored. Currently, potential DOE disposal sites for Subsurface Disposal Area wastes include the Waste Isolation Pilot Plant for transuranic waste, the Hanford Site for mixed low-level waste, and the Nevada Test Site for low-level waste.

3.5.1 Waste Isolation Pilot Plant

Transuranic waste from the remediation of the Subsurface Disposal Area could be considered for disposal at the Waste Isolation Pilot Plant provided that capacity is available, the INEEL is a certified generator, and the waste acceptance criteria are met.

The DOE issued a record of decision (DOE 1998b) to dispose of transuranic waste at the Waste Isolation Pilot Plant, a mined repository located 2,100 feet below the surface in an ancient salt deposit near Carlsbad, New Mexico. Under this Record of Decision, the Waste Isolation Pilot Plant will receive up to 175,600 cubic meters (6.2 million cubic feet) of transuranic waste generated by defense activities. This waste includes both contact- and remote-handled transuranic waste placed in retrievable storage after 1970, and transuranic waste generated through approximately 2033. Future waste-generating activities could include plutonium stabilization and management, defense transuranic waste from sites where transuranic waste was buried before 1970, decontamination and decommissioning, waste management, and defense testing and research. The Waste Isolation Pilot Plant waste acceptance criteria (DOE 1996) require that transuranic waste contain polychlorinated biphenyls in concentrations less than 50 parts per million and a transuranic concentration greater than 100 nanocuries per gram. Efforts are currently ongoing to permit disposal of mixed transuranic waste (i.e., transuranic waste containing both radioactive and hazardous constituents) at the Waste Isolation Pilot Plant.

On November 13, 1998, the New Mexico Environmental Department issued a final Draft Resource Conservation and Recovery Act Part B Permit (EPA 1998a) for the Waste Isolation Pilot Plant and published notice of a public hearing and the opportunity to provide public comment. The public hearing was held on February 22, 1999, to accept public comment on the final Draft Permit. The previous version of the Draft Permit (EPA 1998b) was issued on May 15, 1998, and the comment period for this version ended on August 14, 1998. The DOE-Carlsbad Area Office has the responsibility to interface with the New Mexico Environmental Department and EPA to resolve the comments on the Waste Isolation Pilot Plant Part B Permit. The final Draft Permit is under review at the INEEL to assess DOE comment resolution and determine whether significant changes to the requirements for characterization and certification of waste are necessary, compared to the requirements that have been used for planning purposes.

The DOE planning for disposal of transuranic-contaminated waste was based on the Waste Isolation Pilot Plant being open. At least a 16 to 18-month delay in the opening of the Waste Isolation Pilot Plant is anticipated to accommodate the permitting process. In addition, the proposed requirements of the May 15, 1998, Draft Permit introduced potential changes in the analytical techniques and requirements for characterizing waste and required the New Mexico Environmental Department to certify the generator site (e.g., the INEEL) for shipment to Waste Isolation Pilot Plant. The certification and permit modification process is estimated to take three months to two years.

3.5.2 Nevada Test Site

Low-level waste from remediation of the Subsurface Disposal Area could be considered for disposal at the Nevada Test Site provided that capacity is available, the INEEL is an approved generator, and the waste acceptance criteria are met.

In the past, disposal of low-level INEEL waste at the Nevada Test Site has been considered because of the limited capacity of the active disposal pit at the RWMC. The environmental impact statement for the Nevada Test Site (DOE-NV 1996a) classified sites such as the INEEL as off-site locations. The Record of Decision (DOE-NV 1996b) following issuance of the environmental impact statement identified the following:

> Disposal of low-level waste will continue for waste streams from current on-site and off-site waste generators. This represents the No Action Alternative of disposal capability for currently approved waste generators. Approval of other waste generators for disposal is pending future programmatic decisions. The DOE will continue to expand and create new disposal cells as necessary within the designated Radioactive Waste Management Zones.

The INEEL is not currently an approved waste generator at the Nevada Test Site.[b] The waste being considered for disposal at the Nevada Test Site is low-level radioactive waste. Efforts to obtain approval for shipping low-level waste to the Nevada Test Site for disposal in fiscal year 1998 were unsuccessful because the Nevada Test Site is not accepting new generators until DOE establishes a complex-wide plan for disposal of all waste types (Clements 1998).

3.5.3 Hanford Mixed Waste Disposal

Mixed low-level waste from remediation of the Subsurface Disposal Area, including waste with transuranic concentrations less than 100 nanocuries per gram, could be considered for disposal at the Hanford Site provided that capacity is available, the INEEL is an approved generator, and the waste acceptance criteria are met.

Correspondence from DOE-Richland authorizing the INEEL as a waste generator for disposal of low-level waste at Hanford (Teynor 1997) was rescinded (Hansen 1998a). As a result, the INEEL is not currently an approved waste generator at Hanford. Hanford is not authorizing new generators and has discontinued receipt of off-site mixed waste until DOE establishes a complex-wide plan for disposal of all waste types (Hansen 1998b).

3.5.4 Disposal Options Summary

Though the remedial alternatives that will be applied to the Subsurface Disposal Area will not be determined until the Waste Area Group 7 comprehensive investigation record of decision is developed, it is possible that waste requiring disposal outside the INEEL could result from remediation activities. Therefore, disposal alternatives will continue to be evaluated for final disposition of possible waste generated during remedial activities at the Subsurface Disposal Area. Because remediation of the Subsurface Disposal Area could generate transuranic, low-level, and mixed low-level waste, disposal facilities for all three different types of waste will be considered.

b. Personal communication between R.R. Piscitella, Lockheed Martin Idaho Technologies Company, and Carl Shelton, Department of Energy, Nevada Test Site, December 10, 1997.

4. CONTAMINANT MIGRATION AND THREATS TO GROUNDWATER

The conditions affecting the assessment of potential risk to human health and the environment are the physical setting of the RWMC, the nature and extent of contamination, and the ability of the contamination to migrate. The currently available information is summarized below.

4.1 Physical Setting

The INEEL lies within a geologic formation known as the Snake River Plain. The plain is a generally flat high-country desert extending from the western Oregon border across Idaho to Wyoming, and is bounded on the north and south by mountains and on the east by Yellowstone National Park. The INEEL encompasses approximately 890 square miles of the Eastern Snake River Plain immediately adjacent to the mountains that form the plain's northern boundary. The average annual precipitation at the INEEL is 8.7 inches per year. The entire INEEL overlies the Snake River Plain Aquifer, as shown in Figure 2.

The RWMC is located in the southwestern portion of the INEEL within a shallow natural depression surrounded by ridges of basalt rock. Local surface soils range in thickness from 2 to 23 feet. The closest surface water feature is the Big Lost River about two miles to the north. However, the local depression tends to hold precipitation and to collect additional rain and snowmelt from the surrounding slopes. The RWMC Subsurface Disposal Area has been flooded by local runoff on three occasions because of a combination of snowmelt, rain, and warm winds. Dikes and drainage channels were constructed around the buried waste following the first flood in 1962. Additional improvements were implemented after flooding in 1969 and 1982. Localized runoff from surrounding slopes is now prevented from entering the Subsurface Disposal Area by the perimeter drainage channel and dike surrounding the facility. Runoff from within the Subsurface Disposal Area is directed away from the disposal area. Ultimately, surface water infiltrates through the vadose zone to the underlying Snake River Plain Aquifer, which lies approximately 600 feet beneath the RWMC.

The subsurface region between the land surface and the Snake River Plain Aquifer is called the unsaturated or vadose zone. The vadose zone beneath the RWMC is a complex series of thick, highly variable undulating layers of fractured basalt interspersed with comparatively thin layers of sediment called interbeds. Data collected from well drilling have been used to describe the features of the vadose zone. Ten major basalt layers and seven interbeds have been identified in the vadose zone beneath the RWMC. However, all of the interbeds have gaps in some locations.

The three uppermost interbeds are called the 30-foot, 110-foot, and 240-foot interbeds after their respective average depths from the surface. The 30-foot interbed is highly discontinuous and offers little protection to the aquifer, but the 110-foot and 240-foot interbeds provide significant barriers to moisture infiltration and contaminant movement. The 240-foot interbed is the most continuous. To preserve the aquifer protection this interbed provides, drilling through the 240-foot interbed beneath the Subsurface Disposal Area is performed on a limited basis.

Generally, infiltrating water migrates through basalt much faster than through the interbeds, which tend to retard infiltration to the underlying aquifer. Because the interbeds retard infiltrating water, moisture can accumulate in the vadose zone above the interbeds. These small, saturated areas are called perched water bodies. Accumulations of water above the interbeds in the vadose zone have been identified above the 110-foot and 240-foot interbeds beneath the RWMC. Generally, perched water beneath the RWMC is transitory because a constant recharge source such as an evaporation pond is not located nearby. The sources of perched water may be surficial infiltration, lateral water movement in the subsurface, surface flooding, or a combination of sources. Perched water beneath the RWMC has been detected in 11 boreholes at various times. Wells tapping the perched water are typically dry or contain so little moisture that the water volume collected for analysis is limited.

The Snake River Plain Aquifer is the saturated area beneath the vadose zone and is classified as a sole-source aquifer by the EPA (56 FR 50634). Like the unsaturated zone above, the aquifer is composed of complex layers of basalt and interbeds. The highly fractured and porous characteristics of the basalt, coupled with large and small empty spaces in the rock, provide water storage capacities somewhat analogous to that of a sponge. Extending under the entire Eastern Snake River Plain, the aquifer holds approximately the same volume of water as Lake Erie. The aquifer is recharged through infiltration of waters from the surface. Because topography prevents surface water in the region from flowing directly to the Snake River, the aquifer is recharged by snowmelt from the mountains surrounding the plain and precipitation that falls directly on the plain. The aquifer flows generally from northeast to southwest, reaching the surface to discharge into the Snake River about 100 miles southwest of the INEEL.

4.2 Nature and Extent of Contamination

The contaminants, concentrations, types of contaminated media, and boundaries of contamination in the environment, described as the nature and extent of contamination, are typically defined through long-term, systematic contaminant monitoring and sampling. However, environmental monitoring and sampling requirements at the RWMC have changed over time to comply with regulations and accommodate the needs of the various sponsoring programs. Therefore, the description of the nature and extent of contamination is limited by the inconsistent monitoring and sampling coverage implemented in the past. Recent initiatives have consolidated the monitoring sampling programs, but insufficient data exist for an adequate evaluation. Furthermore, the area is large, the geology is complex, and contaminant migration is not fully understood. Therefore, conclusions about the nature and extent of contamination associated with the Subsurface Disposal Area cannot be developed based on the existing set of analytical data alone. A thorough review of the existing data has led to plans to enhance the data collection network. This enhancement will consist of additional wells and coreholes located inside and around the burial ground. These wells and coreholes will be installed in the summer of 1999 to provide information necessary to support the baseline risk assessment.

The current monitoring program focuses on the potential threat to the aquifer beneath the RWMC by identifying the contaminants that have migrated from the buried waste and how far those contaminants have moved. Both the vadose zone and the aquifer are monitored. In addition to regular monitoring, samples of vadose zone materials collected during well drilling have been analyzed. Though available data will not support a concise description of the nature and extent of contamination, evidence supports the conclusion that some contaminants have migrated into the environment from the buried waste. The monitoring network is being expanded to provide better coverage. Ultimately, all of these data will be used to refine predictions of contaminant migration and risk. The analysis of the nature and extent of contamination, based on limited data from the vadose zone and the aquifer, is summarized below.

4.2.1 Vadose Zone

The vadose zone comprises the unsaturated rock and soil between the ground surface and the top of the Snake River Plain Aquifer. At the Subsurface Disposal Area, the vadose zone is approximately 600 feet thick. The vadose zone is monitored by collecting soil moisture samples, perched water, and vapor. Data from the analysis of interbed materials also are used to define the nature and extent of contamination in the vadose zone.

4.2.1.1 Soil Moisture. The vadose zone monitoring network at the Subsurface Disposal Area includes shallow and deep suction lysimeters, but none of them are located within the waste pits. A total of 41 suction lysimeters have been installed in the shallow surficial sediments in and around the Subsurface Disposal Area. Currently, 30 of the shallow lysimeters are operational and 14 have yielded a water sample at least once within the last two years. Uranium and plutonium isotopes, tritium, technetium-99, americium-241, and carbon-14 have been detected. However, the data do not demonstrate a clear pattern of contaminant migration over time. For example, technetium-99 was detected in one shallow lysimeter in the spring of 1997 but has not been detected in subsequent sampling. Likewise, americium-241 was detected in one shallow lysimeter in the winter of 1998 but has not been detected since. Seven deep suction lysimeters were installed within interbeds beneath the Subsurface Disposal Area at depths ranging from 32 to 227 feet. Four have yielded water samples at least once. Water samples from the deep lysimeters, including one located 300 feet outside of the Subsurface Disposal Area, have yielded positive detections of radionuclides.

4.2.1.2 Perched Water. Perched water has been detected in six of 45 wells drilled within the Subsurface Disposal Area, primarily above the 110-foot and 240-foot interbeds. Perched water sampling is attempted quarterly, but only one well yields sufficient perched water volume to allow sample analysis on a fairly consistent basis. Therefore, most perched water data are from one location. Elevated concentrations of cesium-137, strontium-90, transuranic elements, several elemental metals, and volatile organic compounds including carbon tetrachloride, have been detected in the perched water above the 110-foot and 240-foot interbeds. The presence of these contaminants in the perched water beneath the landfill indicates that migration from the buried waste has occurred.

4.2.1.3 Soil Gas. Volatile organic compounds are locally ubiquitous in the soil gas at the Subsurface Disposal Area. These contaminants are not naturally occurring. Therefore, any detected concentration is considered greater than an assumed background concentration of zero. Sampling of 169 vapor ports in 39 wells is conducted to monitor organic contaminant concentrations at various depths in the vadose zone in the vicinity of the RWMC. The highest concentrations (3,000 to 5,000 parts per million volume) have been measured between Pits 4, 6, and 10 in the center of the Subsurface Disposal Area (see Figure 4) above the 110-foot interbed. The primary volatile organic compounds detected within and around the Subsurface Disposal Area are carbon tetrachloride, chloroform, and trichloroethylene with carbon tetrachloride being the most widespread and concentrated. The contamination extends from land surface down to the water table and greater than 3,000 feet from the Subsurface Disposal Area boundary.

Soil gas contaminated with volatile organic compounds has been measured emanating from the surface of the Subsurface Disposal Area. Eleven compounds have been detected: carbon tetrachloride; trichloroethylene; chloroform; tetrachloroethene; methylene chloride; 1,1,1-trichloroethane; toluene; acetone; 2-butanone; dichlorodifluoromethane; and dichloropropane. The highest emissions were for carbon tetrachloride. Results show a high degree of spatial and temporal variability. For example, one location had an emission rate of 38 milligrams per square meter per minute during 1992, and six months later an emission could not be detected at the same location. The variability is caused primarily by the proximity to the source, source conditions, soil conditions, and weather conditions.

4.2.1.4 Interbed Sediments. Well drilling operations have provided opportunities to collect samples from interbed sediments beneath and near the Subsurface Disposal Area. The presence of contamination in an interbed indicates that contaminants have migrated from the Subsurface Disposal Area and could potentially reach the underlying aquifer. As discussed above, the presence of elemental metals and volatile organic compounds in the vadose zone is well known. Therefore, the primary focus of current analysis is the migration of radioactive contaminants.

The vadose zone samples were classified for evaluation in three depth intervals. The intervals delineate the approximate depths of the first three interbeds beneath the Subsurface Disposal Area (i.e., the 30-foot, 110-foot, and 240-foot interbeds). Radionuclides have been detected in all three intervals.

4.2.2 Snake River Plain Aquifer

Data from 34 groundwater monitoring wells in the RWMC area are collected quarterly. The U.S. Geological Survey has installed and monitors most of these wells, and has established background values for some contaminants. Samples are analyzed for metals, nitrates and nitrites, volatile organic compounds, tritium, carbon-14, strontium-90, technetium-99, iodine-129, plutonium-238, plutonium-239/240, americium-241, neptunium-237, uranium isotopes, gamma-emitting radionuclides, and gross alpha and gross beta activity. The strontium-90 analysis is performed only if the gross beta result is greater than 5 picocuries per liter.

Though several contaminants have been detected at concentrations higher than background levels on at least one occasion, the monitoring data vary widely and show no clear trend in concentrations. Uranium has been detected in some of the wells, but concentrations are at or below the background levels. Other actinides have been detected sporadically, but consistent detection is not evident and the detected concentrations are well below drinking water standards. Presently, it is unclear whether the actinide contamination in the aquifer is from the Subsurface Disposal Area or an upgradient source. Tritium is the only radioactive contaminant that is consistently detected above background levels. Compared to a background value of 0.15 picocuries per milliliter, the highest tritium concentration detected in the RWMC vicinity is 35.5 picocuries per milliliter. However, a tritium plume is associated with the Idaho Nuclear Technology and Engineering Center, an INEEL facility located upgradient of the RWMC. Therefore, the Subsurface Disposal Area contribution is not well defined. Four new upgradient monitoring wells were installed in 1998. Data from these wells will help to determine the magnitude of the Subsurface Disposal Area contribution to the tritium concentrations detected beneath the Subsurface Disposal Area.

Carbon tetrachloride and other volatile organic compounds have been detected regularly in the aquifer at levels considerably greater than an assumed background value of zero. Carbon tetrachloride concentrations slightly above the maximum contaminant level for drinking water of 5 micrograms per liter have been detected, and the trend in measured carbon tetrachloride concentrations is generally increasing. However, the monitoring data vary widely. For example, carbon tetrachloride has been detected in one well at concentrations increasing from 1 microgram per liter in the fall of 1993 to 6 micrograms per liter in the fall of 1995, but subsequently has not been detected in that well.

Elemental metals such as antimony, beryllium, cadmium, chromium, lead, magnesium, manganese, mercury, nickel, and phosphorus also have been detected in concentrations greater than background values. Antimony, beryllium, cadmium, lead, manganese, and mercury have been detected at least twice above maximum contaminant levels for drinking water. Like the radionuclides and volatile organic compounds, the metals are detected sporadically and clear trends are not evident.

The U.S. Geological Survey periodically samples groundwater around the RWMC. Downgradient concentrations of chromium and nitrate have been detected regularly since 1988. Nitrates are regularly detected in concentrations in excess of the 5 milligrams per liter background value and have been detected in concentrations greater than the 10 milligrams maximum contaminant level for drinking water on at least nine occasions (Becker et al. 1998).

4.3 Human Health Risk Estimates

An interim risk assessment for the Subsurface Disposal Area was completed in 1998 (Becker et al. 1998). A baseline for potential risks was developed by evaluating current occupational and future occupational and residential exposure scenarios without remediation applied to mitigate potential risks. Carcinogenic and noncarcinogenic risks were assessed using deterministic methods to identify the upper limits of risks. The models used to develop the interim risk assessment were only partially calibrated. Data to support additional calibration are currently being gathered through sampling and analysis. Until this effort is complete, risk estimates will be uncertain. However, sufficient data do exist to allow development of conservative assumptions for the interim risk assessment and to justify eliminating from further evaluation contaminants that were demonstrated in the interim risk assessment to generate insignificant risk.

The most important conclusions from the interim risk assessment are that (1) the future baseline risk assessment will focus on the risk-driving contaminants identified in the interim risk assessment, (2) groundwater ingestion is the primary exposure pathway of concern, (3) the most imminent risk is generated by the volatile organic compounds, especially carbon tetrachloride, and (4) additional data are required to refine the risk estimates and evaluate remedial alternatives for the Waste Area Group 7 comprehensive investigation. The baseline risk assessment will be complete in August 2002.

5. POTENTIAL PRIVATIZATION PROGRAM TO REMEDIATE THE SUBSURFACE DISPOSAL AREA

Historically, the management and operations contractor has managed projects implemented at the INEEL and, except for construction, used its own employees to implement projects in facilities financed and owned by the government. Alternatively, under a privatization concept, DOE or the INEEL management and operations contractor obtains the required services directly from a vendor with specialized skills, technologies, and facilities. Projects are considered "traditional" when a facility is designed, financed, constructed, and operated under DOE control. Typically, DOE then owns the facility, and its operation and control is managed by the management and operations contractor. In the context of a remediation, a privatized contract is one in which a private sector contractor finances and administers the remediation with its selected or developed technologies and designs. Typically, payments to the private sector contractor will be for delivered products (e.g., treated waste) or service provided. The private contractor then owns any facility constructed, and controls its operation. The contract can be awarded directly by DOE or through its management and operations contractor. Unless the work is performed at facilities off the INEEL site, DOE maintains responsibility for safety, health, and environmental impacts of privatized operations.

The remedial options being evaluated for the Subsurface Disposal Area include capping, in situ treatments using standard technologies, in situ treatments using specific technologies offered by specific vendors, ex situ treatments by an existing private vendor, and ex situ treatments through a new facility. Some of the in situ treatments, such as grouting, are highly intrusive whereas others, such as containment with a cap, are nonintrusive. Any intrusive remedy, whether in situ or ex situ, will involve disturbance of heterogeneous mixed waste and other debris with a potential for encountering high-radiation fields, fissionable material, void spaces, and hazardous material. The ability of the selected technology to safely address these hazards while satisfying waste treatment objectives must be evaluated and factored into any decision under the record of decision. Handling unanticipated wastes will require flexibility in the contracting approach, though differing site conditions clauses can be used to shift the risk of unknowns to the government.

Factors that now should be used to evaluate the suitability of including a project in the Privatization Program are discussed in recently developed draft guidance, "Program/Project Manager's Privatization Guide" (DOE 1998a). These factors are cost, mission, schedule, regulatory concerns, technology, procurement issues, vendor availability, risk, stakeholder input, and miscellaneous other concerns. Other factors of primary importance include the maturity of the technology selected and the pool of competent, interested bidders. For some of the in situ options being considered, the pool of competent vendors is very small, limiting the price advantage of privatizing. The pool of vendors is larger for cap design and construction and some ex situ options, providing more opportunity for cost savings through competition and efficiency.

To evaluate the suitability of the Subsurface Disposal Area remediation for privatization against the factors presented in the draft guidance (DOE 1998a), the scope of the remedy must be known. Because the evaluation of potential remedies for the Subsurface Disposal Area is still in progress with the DOE Idaho Operations Office, EPA, and the State of Idaho, the scope of the remedy has not been defined. Therefore, no conclusions as to the appropriateness of privatization can be drawn at this time.

6. CURRENT STRATEGY FOR THE RWMC AND IMPACTS OF THE PIT 9 PROJECT

To support the Waste Area Group 7 decision process, a number of data gaps must be filled. The significant data gaps relate to release of contaminants from the waste, contaminant movement in the subsurface, risk assessment, and assessment of additional potential treatment technologies. The revised scope of work for the Waste Area Group 7 comprehensive investigation (LMITCO 1997b) and the Work Plan Addendum (DOE-ID 1998) outline the strategy for satisfying the Waste Area Group 7 data needs. An independent strategy has been developed for Waste Area Group 7 that parallels some of the activities defined for the revised Pit 9 interim action. Should circumstances allow, common resources will be optimized by using Pit 9 strategies for similar activities (i.e., probehole and coring methodology, cold tests, approvals, document development and safety reviews for field characterization and technology deployment, and ex situ soil treatments studies). Any timely data generated by these activities will be incorporated into the Waste Area Group 7 comprehensive investigation. Data gaps include the following:

- Additional environmental data to define the nature and extent of contamination for model calibration and the baseline risk assessment

- More accurate source term data to support the baseline risk assessment and modeling

- Fate and transport calibration data and source release information to improve the baseline risk estimates and enhance confidence in the results

- Enhanced data sets to support rigorous evaluations of sensitivity and uncertainty to quantify confidence in the future baseline risk assessment

- Additional data to support the unbiased assessment of the applicability and implementability of various remediation technologies to Subsurface Disposal Area waste, conditions, and scale

- Additional data to evaluate candidate remedial technologies against the nine CERCLA criteria (i.e., overall protection; compliance with the law; long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; cost; state acceptance; and community acceptance) (EPA 1988).

Lessons learned through review of the Government Accounting Office evaluation of the Hanford vadose zone study (GAO 1998) were incorporated in the data gap analysis for Waste Area Group 7. The Hanford evaluation concluded that the understanding of migration of waste through the vadose zone to groundwater at Hanford is not adequate to make key technical decisions about approaches for mitigating risk in an environmentally sound and cost-effective manner. Because the Hanford vadose zone is remarkably similar to the vadose zone beneath the Subsurface Disposal Area, the Government Accounting Office findings are relevant to Waste Area Group 7. The results of the studies listed above, in combination with data from INEEL infiltration tests and other vadose zone studies, will ensure that the understanding of contaminant migration at Waste Area Group 7 is sufficiently understood to support sound remedial decisions. The discussions below focus on the major components of the strategy:

- Limited waste zone characterization
- Environmental monitoring
- Treatability studies to evaluate additional waste treatment options.

6.1 Limited Characterization of the Waste Zones

Additional waste zone data are required for the baseline risk assessment and the feasibility study for Waste Area Group 7. Characterization data are required to identify site-specific parameters for fate and transport modeling, reduce the uncertainties associated with contaminant release from the buried waste, and enhance the quality of the comprehensive baseline risk assessment for Waste Area Group 7. For the feasibility study, waste materials are required for an ex situ treatment study and data to select locations within the Subsurface Disposal Area for in situ field-scale tests are needed. To satisfy these needs, cores will be drilled through selected waste zones in the Subsurface Disposal Area to collect waste and soil samples. The objectives of the drilling program are to retrieve samples of waste that contain Rocky Flats organic sludge and identify optimal locations for the treatability studies.

Up to 22 coreholes will be drilled within the Subsurface Disposal Area. Three holes will be drilled in each of three locations in Pit 10 to support the baseline risk assessment. Seven holes will be drilled in Pit 4 to support field-scale in situ treatment treatability studies, and 6 holes will be drilled in Pit 9 to provide materials for ex situ treatment treatability studies and support the objectives of the Pit 9 Record of Decision. The locations of waste pits are shown in Figure 4. Samples of waste and contaminated soils will be collected from the coreholes and analyzed for content and characteristics. These data will be used to characterize the Subsurface Disposal Area, calibrate fate and transport models, develop risk estimates, provide a baseline for measuring the effectiveness of in situ and ex situ remedial alternatives, and generally support the development of the Waste Area Group 7 comprehensive investigation.

6.2 Environmental Monitoring

The current environmental monitoring program will continue with the quarterly collection of samples for analysis from the aquifer, perched water, and lysimeters located within the RWMC. The analyte list has been expanded to include contaminants such as uranium isotopes and neptunium-237 that may be a health risk. The intent is to gather a consistent set of data over the next two years on which to base the record of decision for Waste Area Group 7 and to provide a baseline for measuring the effectiveness of remedial actions. In addition, several improvements to the monitoring system were identified during the efforts to determine the nature and extent of contamination. Two enhancements to the monitoring network have already been implemented: (1) four new aquifer wells were drilled upgradient from the Subsurface Disposal Area in the summer of 1998, and (2) five additional lysimeters were installed within the Subsurface Disposal Area.

The planned coring within Pits 4 and 10 offers another opportunity to improve the monitoring network by installing lysimeters and other monitoring equipment in the coreholes. None of the lysimeters in the existing shallow monitoring network (see Section 4.2.1.1) are located within waste zones. Instead, the monitoring wells are located between the pits and trenches. By installing monitoring equipment within the coreholes, monitoring data from the waste media will become available. These data will be used to assess contaminant migration from the waste into the vadose zone and will provide much needed information on the composition of the waste and an improved description of release from the source.

6.3 Waste Treatment Options and Treatment Technology Studies

The original planning for eventual remediation of the Subsurface Disposal Area was founded on the assumption that retrieval and ex situ treatment of the waste and contaminated soil in the landfill would be required. This assumption was based on the evaluation of remedial alternatives for Pit 9 and preliminary investigation of the potential remedial strategies that could be applicable to the remainder of Waste Area Group 7. These evaluations were conducted in the late 1980s and early 1990s. Since then, several in situ treatment technologies have matured sufficiently to warrant consideration for the Subsurface Disposal Area. These in situ options may allow treatment of waste in place with lower risk to workers, fewer regulatory complications, and reduced cost to the taxpayer.

Methodologies recommended by the EPA (1989) were used to evaluate and select treatability studies to support the feasibility study and the Waste Area Group 7 record of decision. The evaluation was based on the significance of feasibility study data gaps associated with each technology and whether bench-, pilot-, or field-scale testing would be required to collect the necessary data. Other factors considered by the DOE Idaho Operations Office, EPA, and the State of Idaho to identify treatability studies for Waste Area Group 7 were budget and schedule constraints, technology availability, level of technology development and demonstration, and potential applicability at the Subsurface Disposal Area. Eight technologies were determined to warrant treatability studies. The technologies will be evaluated in the following five treatability studies:

- In situ vitrification
- In situ grouting for (1) long-term disposal and (2) contaminant confinement during waste retrieval
- In situ thermal desorption
- Ex situ soil treatments (two treatability studies):
    - For Operable Unit 7-13/14 (Waste Area Group 7), evaluation of (1) electrochemical oxidation, and (2) high-gradient magnetic separation
    - For Operable Unit 7-10 (Pit 9), evaluation of (1) chemical extraction, (2) elutriation, and (3) wet screening.

The five treatability studies will provide additional information for detailed analysis of remedial alternatives in the feasibility study, aid in identifying preferred remedial alternatives for the Subsurface Disposal Area, and expedite the implementation of selected alternatives. By performing the studies, uncertainties associated with these remedial alternatives will be reduced, providing a better foundation for recommendations and the remedy selection for the Subsurface Disposal Area.

The overall objective of each treatability study is to provide sufficient data to evaluate the technology against the nine CERCLA criteria. Each of the five proposed treatability studies is discussed below. Included in each discussion are a brief description of the technology, its potential application to waste buried at the Subsurface Disposal Area, and a general strategy for conducting the treatability study.

In accordance with its contract with the DOE, BNFL Inc. is currently in the process of constructing the Advanced Mixed Waste Treatment Facility adjacent to the landfill at the RWMC. This facility is being designed to treat aboveground stored waste similar in nature to much of the waste buried at the RWMC. Because this facility will be capable of treating waste if the waste is removed from the burial ground, additional treatability study information is not required for treatment of excavated waste. However, because the Advanced Mixed Waste Treatment Facility will not be designed to treat soil, the ex situ soil treatment studies are required.

6.3.1 In Situ Vitrification Treatability Study

In situ vitrification technology was developed to immobilize contamination by melting the contaminated media and then allowing the melted waste to cool and coalesce into an obsidian-like glass. In situ vitrification has been used at both hazardous and radioactive contaminated sites. The technology has advanced significantly during the past several years and warrants consideration for application at the Subsurface Disposal Area.

The technique is effective for treating buried debris and soil contaminated with radionuclides, heavy metals, organic compounds, asbestos, polychlorinated biphenyls, and pesticides. Based on research and operating experience, several issues associated with the effectiveness and implementability of the technology in a buried waste environment will be thoroughly tested. The testing phase includes a large-scale test on simulated waste followed by large-scale testing in Pit 4 of the Subsurface Disposal Area.

The in situ vitrification process with the most applicability to waste buried in the Subsurface Disposal Area is conventional joule-heated in situ vitrification, which was developed by Battelle Memorial Institute in 1980 at the Pacific Northwest National Laboratory near Richland, Washington. With joule-heated in situ vitrification, melting is initiated at or near the ground surface and proceeds from top to bottom until the desired melt depth is achieved. The molten soil and waste then are allowed to cool and solidify into a highly leach-resistant monolith with properties similar to that of basalt. The high operating temperature of in situ vitrification is effective for the treatment of organic compounds (including polychlorinated biphenyls and dioxins) and miscellaneous debris such as asbestos, concrete, wood, paper, plastic, and scrap metal. The process has been used at a number of Superfund hazardous waste sites that contained an assortment of contaminated soil, buried waste, and miscellaneous debris, and is currently being applied to buried transuranic waste at a former nuclear test site in Australia.

The philosophy of the in situ vitrification treatability study is to manage the evaluation of the technology through a graded risk-based approach. Based on research and operating experience, several issues associated with the effectiveness and implementability of the technology in the buried waste environment will be assessed thoroughly. Some of these issues may be "show-stoppers" if they are not adequately resolved. Hence, several formal decision points are structured into the treatability study to ensure that these key issues will be addressed satisfactorily before committing resources to more expensive testing phases. For each of these decision points, specific criteria will define the next step.

The treatability study will incorporate data from previous in situ vitrification testing and applications and surveillance of ongoing in situ vitrification activities in the United States and abroad. The treatability study is structured to focus on critical data gaps specific to application at the Subsurface Disposal Area. Five phases for the in situ vitrification treatability study have been defined as described in Table 1.

Table 1. Five phases of the in situ vitrification treatability study.

Phase	Description	Location	Schedule
1	Preliminary evaluation of key uncertainties	INEEL	June 1998 to November 1998
2	Development of test documentation for large-scale testing of simulated and actual waste	INEEL	October 1998 to September 1999
3	Implementation of a large-scale test on simulated waste	INEEL—RWMC Cold Test Pit	November 1999 to December 1999
4	Implementation of a large-scale test on actual Subsurface Disposal Area waste	INEEL—RWMC Pit 4	June 2000 to August 2000
5	Data evaluation and reporting	INEEL	September 2000 to March 2002

6.3.2 In Situ Grouting Treatability Study

The in situ grouting treatability study will assess two potential applications: (1) grouting for long-term containment in place, and (2) grouting as a pretreatment to control radioactive contamination during waste retrieval. Both applications will be evaluated in a single treatability study using several grouts. To achieve the objectives, a five-phase strategy is being implemented as given in Table 2.

Table 2. Five phases of the in situ grouting treatability study.

Phase	Description	Location	Schedule
1	Work scope planning including the establishment of specific test-performance goals	INEEL	June 1998 to April 1999
2	Development of all documentation for the grout selection process and the field-scale testing	INEEL	October 1998 to April 2000
3	Identification of applicable grouts for the Subsurface Disposal Area via bench-scale testing	INEEL—by an off-site vendor	July 1999
4	Construction of a test pit to simulate a Subsurface Disposal Area waste zone and performance of field-scale testing	INEEL—RWMC Cold Test Pit	April 2000 to May 2000
5	Data evaluation and reporting	INEEL	August 1999 to July 2001

6.3.2.1 In Situ Grouting for Containment in Place. For in situ grouting for containment in place, the grout is injected into a buried waste area (i.e., a waste pit and contaminated soils) to produce a stable soil-waste monolith. The monolith chemically and physically stabilizes buried waste for in situ disposal. Buried waste containers, such as drums and boxes, are penetrated, and the contents are incorporated into the matrix. The monolith will be protective by (1) chemically reducing contaminant mobility, (2) enhancing the structural stability of the site for long-term cap performance, (3) inhibiting groundwater infiltration through the monolith, and (4) inhibiting plant and animal intrusion into the monolith.

Jet grouting was identified as the likely method for injecting grout for the in situ grouting long-term disposal treatability study. Injection of the grout causes the soil, debris, and grout to mix, and results in a solid monolith with the contaminants entrained or encapsulated in the body of the monolith. The monolith is created by drilling and grouting multiple holes in a pattern to form a series of vertical, overlapping grout columns without seams. A number of different grout materials can be used, and several have been demonstrated in both simulated and actual waste.

Verification and monitoring of the stabilized waste are important considerations for in situ grouting for long-term disposal. Verification will assess the effectiveness and durability of the treatment. Because this treatment option would leave contaminated media in the Subsurface Disposal Area, long-term monitoring would be required to ensure the continued performance of the remediation. Both verification and monitoring will be addressed in the treatability study to provide information for alternative evaluation during the feasibility study.

In situ grouting has been used successfully at the Acid Pit, a contaminated soil pit in the Subsurface Disposal Area (see Figure 4). This technology has been developed to a point that application to the Subsurface Disposal Area buried waste site is appropriate. By testing complex simulated Subsurface Disposal Area waste scenarios, the treatability study will focus on the evaluation of the technology for long-term performance and stabilization of Subsurface Disposal Area contaminants of potential concern.

6.3.2.2 In Situ Grouting for Confinement and Waste Retrieval. In situ grouting for confinement is similar to in situ grouting for containment in place. Instead of using the technique for long-term disposal, in situ grouting can be used as a pretreatment to confine contamination during waste retrieval. Grout is injected into contaminated waste and soil to produce a monolith and provide interim encapsulation of contaminants during soil and waste retrieval and handling operations. The in situ grouting for confinement treatability study will be important if retrieval is selected as a part of the remedial action. Double-confinement will be required to control contamination spread during waste and soil retrieval operations. In situ grouting is being investigated as a means to reduce the cost of a double-confinement structure by providing the primary confinement with grouting. If the in situ grouting for confinement treatability study produces results that indicate grouts can be used as a primary confinement, the technology will be considered as an option for the Subsurface Disposal Area retrieval alternative in the feasibility study.

The technology is being evaluated in this application as an interim treatment, and is not considered as a final treatment option for Subsurface Disposal Area waste. In situ grouting for confinement has been tested on simulated buried waste at the INEEL Cold Test Pit. The focus of this treatability study is to collect information about uncertainties, primarily associated with the degree to which the contaminated soils and waste can be bound and the effect of the grout on subsequent operations.

6.3.3 In Situ Thermal Desorption Treatability Study

During in situ thermal desorption, contaminated soil and buried waste are heated, sufficiently raising the temperature of the soil and waste to vaporize and destroy most organic compounds. An aboveground vapor vacuum collection and treatment system then destroys or absorbs the remaining organic compounds and vents carbon dioxide and water to the atmosphere. The in situ thermal desorption technology is a form of thermally enhanced vapor vacuum extraction. TerraTherm, a company located in Houston, Texas, and a wholly owned subsidiary of Shell Oil Co., is the patent holder for in situ thermal desorption. The technology is a byproduct of Shell's advanced oil well thermal extraction program.

The in situ thermal desorption technology has features that make it a viable alternative for enhancing remediation of Subsurface Disposal Area volatile organic compounds, particularly carbon tetrachloride. The technology potentially can remove all organic compounds in the waste zone to nondetectable levels and is robust enough for operation in waste zones containing metals, debris, and containerized waste as well as soil. A number of inorganic contaminants, such as the nitrate salts buried on Pad A, also would be destroyed by the in situ thermal desorption temperatures. In addition, the high-temperature in situ thermal desorption process has the potential to chemically stabilize plutonium and other radionuclides and metals.

The in situ thermal desorption treatability study will incorporate data from previous vendor in situ thermal desorption testing and applications and surveillance of ongoing in situ thermal desorption activities. The treatability study will be structured to focus on critical data gaps specific to application at the Subsurface Disposal Area. Five phases for the in situ thermal desorption treatability study have been defined as described in Table 3.

Table 3. Five phases of the in situ thermal desorption treatability study.

Phase	Description	Location	Schedule
1	Preliminary evaluation of key uncertainties	INEEL	June 1998 to December 1998
2	Development of test documentation for large-scale in situ thermal desorption testing	INEEL	October 1998 to September 1999
3	Implementation of a large-scale in situ thermal desorption test on simulated waste	INEEL—RWMC Cold Test Pit	December 1999 to February 2000
4	Implementation of a large-scale test on actual Subsurface Disposal Area waste	INEEL—RWMC Pit 4	March 2000 to May 2000
5	Data evaluation and reporting	INEEL	April 2000 to July 2001

6.3.4 Operable Unit 7-13/14 Ex Situ Soil Treatment Treatability Study

Two bench-scale ex situ treatment tests will be performed under Operable Unit 7-13/14 to evaluate the feasibility of removing contaminants from excavated Subsurface Disposal Area soils. The bench-scale tests will address chemical (i.e., electrochemical oxidation) and physical (i.e., high-gradient magnetic separation) treatment alternatives. The ex situ soil treatments treatability study that will explore the use of electrochemical oxidation and high-gradient magnetic separation is described in this section. The electrochemical- oxidation test will be performed at the INEEL's Test Reactor Area, which has a glove-box facility designed for alpha-confinement. The high-gradient magnetic separation test will be subcontracted to and performed at the Los Alamos National Laboratory. Five phases for the Operable Unit 7-13/14 ex situ soil treatments treatability study have been defined as described in Table 4.

Table 4. Five phases of the Operable Unit 7-13/14 ex situ soil treatments treatability study.

Phase	Description	Location	Schedule
1	Preliminary evaluation of key uncertainties	INEEL	June 1998 to September 1998
2	Development of test documentation for the bench-scale testing	INEEL	October 1998 to July 1999
3	Implementation of the high-gradient magnetic separation bench-scale test on Subsurface Disposal Area soil	Los Alamos National Laboratory	April 2000 to May 2000
4	Implementation of the electrochemical oxidation bench-scale test on Subsurface Disposal Area soils	INEEL	March 2000 to May 2000
5	Data evaluation and reporting	INEEL	June 2000 to May 2001

6.3.4.1 Electrochemical Oxidation. Chemical-treatment testing for cleaning contaminated soil will focus on removing plutonium, americium, and uranium while producing minimal secondary waste. The purpose of chemical treatment is to remove readily water-soluble transuranic contaminants from Subsurface Disposal Area soil. Soluble forms of these contaminants include their nitrate and halogenated salt compounds.

Electrochemical technologies have been developed by several companies to treat contaminated soils in situ. In general, the technologies function by passing an electrical current between two implanted electrodes, which oxidizes the organic contaminants into carbon dioxide and water. If the moisture in the soil is sufficient, electrochemical processes also may remove toxic metals. Similar to what happens in an electroplating process, the metals migrate toward and precipitate at one of the electrodes.

6.3.4.2 High-Gradient Magnetic Separation. High-gradient magnetic separation reduces the volume of contaminated materials by segregating materials based on their magnetic properties. Los Alamos National Laboratory has developed and tested a high-gradient magnetic separator for extracting magnetic components from solids, liquids, and gases.

Because the actinides buried in the Subsurface Disposal Area are paramagnetic (i.e., attracted to a magnetic field as opposed to repelled or unaffected by a magnetic field), high-gradient magnetic separation could be feasible for treating Subsurface Disposal Area soil. High-gradient magnetic separation has been used commercially in the mineral and chemical processing industries to segregate materials on the basis of their magnetic susceptibility. Magnetic separation of actinides can reduce waste volume and minimize the chemical reagents necessary for further remediation of contaminated soil.

6.3.5 Operable Unit 7-10 Ex Situ Soil Treatment Treatability Study

An additional treatability study conducted under the Operable Unit 7-10 Staged Interim Action will implement bench-scale tests to evaluate three ex situ soil treatments to remove contaminants from excavated Subsurface Disposal Area soils. These technologies are chemical (i.e. chemical extraction) and physical (i.e., elutriation and wet screening) treatment alternatives. The tests will be conducted on the INEEL either at the Test Reactor Area or Argonne National Laboratory – West. Five phases for the Operable Unit 7-10 ex situ soil treatments treatability study have been defined as described in Table 5.

Table 5. Five phases of the Operable Unit 7-10 ex situ soil treatments treatability study.

Phase	Description	Location	Schedule
1	Preliminary evaluation of key uncertainties	INEEL	June 1998 to September 1998
2	Development of test documentation for the bench-scale test	INEEL	October 1998 to July 1999
3	Implementation of the chemical extraction bench-scale test on Subsurface Disposal Area soil	INEEL	September 1999 to November 1999
4	Implementation of the elutriation and wet screening bench-scale tests on Subsurface Disposal Area soils	INEEL	September 1999 to November 1999
5	Data evaluation and reporting	INEEL	December 1999 to April 2000

6.3.5.1 Chemical Extraction. The chemical extraction technology under consideration uses water, carbonate buffering agents, chelating agents, and oxidants to remove contaminants from soil. By vigorously mixing the soil with liquid extractants, the carbonates and oxidants help break the attachments between the contaminants and the soil. The chelating agent prevents the contaminant in the liquid from reattaching to the soil before the soil and liquid are separated.

Soil washing technologies using chemical reagents have been used commercially to clean soils contaminated with organics and heavy metals. Though this process has been successfully used to treat INEEL soils containing surrogate contaminants, the formulation for removing plutonium, americium and uranium from genuinely contaminated soil has not been established.

6.3.5.2 Elutriation. Elutriation involves fluidizing a column of contaminated soil with a liquid. The larger, heavier particles descend to the bottom of the column while the smaller or less dense material is carried out with the liquid from the top of the column. Elutriation is commercially used in the mineral processing industry to separate metals from clay and silt containing soils similar to the Subsurface Disposal Area. Usually contamination is associated with the smaller soil particle-size fraction. If this is the case for the Subsurface Disposal Area soils, then elutriation could be useful for consolidating the contamination by separating the larger soil particles from the smaller particles.

6.3.5.3 Wet Screening. For reasons similar to those described for elutriation, wet screening is used in mineral processing to separate the larger soil particles from the smaller ones. Usually a series of screens are arranged vertically with sieve openings that decrease from top to bottom. The soil is placed on the top screen and sprayed with water to wash the small particles into the lower units. If there is a correlation between the soil particle size and the contamination at the Subsurface Disposal Area, then wet screening could be an effective treatment technology.

6.4 Impacts of the Pit 9 Project on RWMC Remediation Plans

As discussed in Section 1.4 above, the subcontract approach for the Pit 9 project failed and the subcontract was terminated. Data from the project planned to support the Waste Area Group 7 comprehensive investigation are incomplete or unavailable, and the enforceable agreement milestones related to the RWMC comprehensive investigation have been renegotiated to allow inclusion of some data from the revised approach to Pit 9. The draft record of decision for the RWMC comprehensive investigation slipped by two and a half years to December 2002 (LMITCO 1997b).

The revised plan presently being implemented for Pit 9, called the Operable Unit 7-10 Staged Interim Action, defines a three-stage project. Stage I is a subsurface investigation; Stage II comprises limited excavation and an ex situ treatment technology demonstration; and Stage III is full-scale remediation of Pit 9. The Stage I and Stage II components will supply data and materials that could be used to support comprehensive investigation modeling and risk assessment activities and ex situ treatment technology tests. However, Stage II will not be completed until September 2003. Because the RWMC draft record of decision is scheduled for December 2002, most data from Stage II of the Pit 9 project will not be available to support the development of the comprehensive investigation and record of decision.

In summary, the Pit 9 project has had major impacts on remediation plans for the RWMC. The schedule for the record of decision for comprehensive investigation has been delayed approximately four and a half years. The comprehensive investigation must acquire data for risk assessment and evaluate ex situ treatment alternatives independent of Pit 9 because these data have not been supplied from the Pit 9 project as had originally been planned.

7. BUDGET PROFILE

The budget profile for the remediation of the RWMC is given in Table 6. Approximately $84 million of the budget is dedicated to completing Stages I and II of the Operable Unit 7-10 Staged Interim Action at Pit 9.

The schedule for completing major work activities for the Waste Area Group 7 comprehensive investigation record of decision is presented in Figure 5. These activities will reduce the uncertainties in the contaminant transport modeling and long-term risk assessment, provide a complete analysis of technical solutions for the Waste Area Group 7 comprehensive investigation record of decision, and fulfill the obligations of the Pit 9 Record of Decision (DOE-ID 1993). The current budget and schedule incorporate the following assumptions for planning purposes:

- Additional remediation of Pad A, Operable Unit 7-12 will not be required
- The current remediation of the organic contamination in the vadose zone under Operable Unit 7-08, in conjunction with treatment of the source (i.e., the buried waste), will sufficiently mitigate migration of volatile organic compounds to the aquifer
- Remediation of groundwater will not be required
- Remediation of the Transuranic Storage Area will not be required
- Remediation of Pit 9 will be successfully completed under the Operable Unit 7-10 Staged Interim Action (see Section 2.3.2.2).

After the draft record of decision for Waste Area Group 7 is submitted in 2002, the annual budget projection approximately doubles in comparison with the preceding years. The substantial increase will be applied to the remediation of the RWMC, which is currently scheduled to commence in 2003. For post-record of decision planning purposes, a hypothetical remediation strategy consisting of partial retrieval, ex situ treatment, waste disposal off the INEEL, a cap over the entire Subsurface Disposal Area, and monitoring and maintenance for 30 years, form the basis for the budget projection. Under this plan, treatment would be complete in 2018, a cap would be installed and the RWMC would be decontaminated and decommissioned by 2024, and maintenance and monitoring would continue through 2054. However, remedial decisions for the RWMC will not be determined until the Waste Area Group 7 comprehensive record of decision is completed. The remedial actions determined in the legally binding record of decision will dictate the final budget needs for Waste Area Group 7.

Table 6. Budget profile for the remediation of the Radioactive Waste Management Complex (Project Baseline Summary Numbers ID-ER-106, Fiscal Year 2000 Congressional Budget Request). Note that these figures are subject to change.

Fiscal Year	Dollars	Planning Basis
1997	4,221,000	Planning, monitoring, ongoing development of the Waste Area Group 7 comprehensive investigation, and the interim risk assessment continue; Operable Unit 7-10 Staged Interim Action initiated.
1998	39,053,000	Characterization, monitoring, treatability studies, and the Operable Unit 7-10 Staged Interim Action continue.
1999	23,700,000	Characterization, monitoring, treatability studies, and the Operable Unit 7-10 Staged Interim Action continue.
2000	50,013,000	Monitoring and the Operable Unit 7-10 Staged Interim Action continue; field-scale in situ treatment treatability studies completed.
2001	32,497,000	Monitoring, treatability studies, and the Operable Unit 7-10 Staged Interim Action continue.
2002	37,616,000	Treatability studies completed; monitoring and the Operable Unit 7-10 Staged Interim Action continue.
2003	70,691,000	Draft Waste Area Group 7 comprehensive investigation record of decision submitted; record of decision finalized and Waste Area Group 7 remediation begins; monitoring and the Operable Unit 7-10 Staged Interim Action continue.
2004	88,165,000	Remediation and monitoring continue; the Operable Unit 7-10 Staged Interim Action completed.
2005	85,896,000	Remediation continues.
2006	77,693,000	Remediation continues.
1997–2006 Total	**509,545,000**	
2007–Completion Total	1,386,785,00	Treatment completed in 2018; cap installed and the site decontaminated and decommissioned by 2024; maintenance and monitoring through 2054.
Grand Total	**1,896,330,00**	

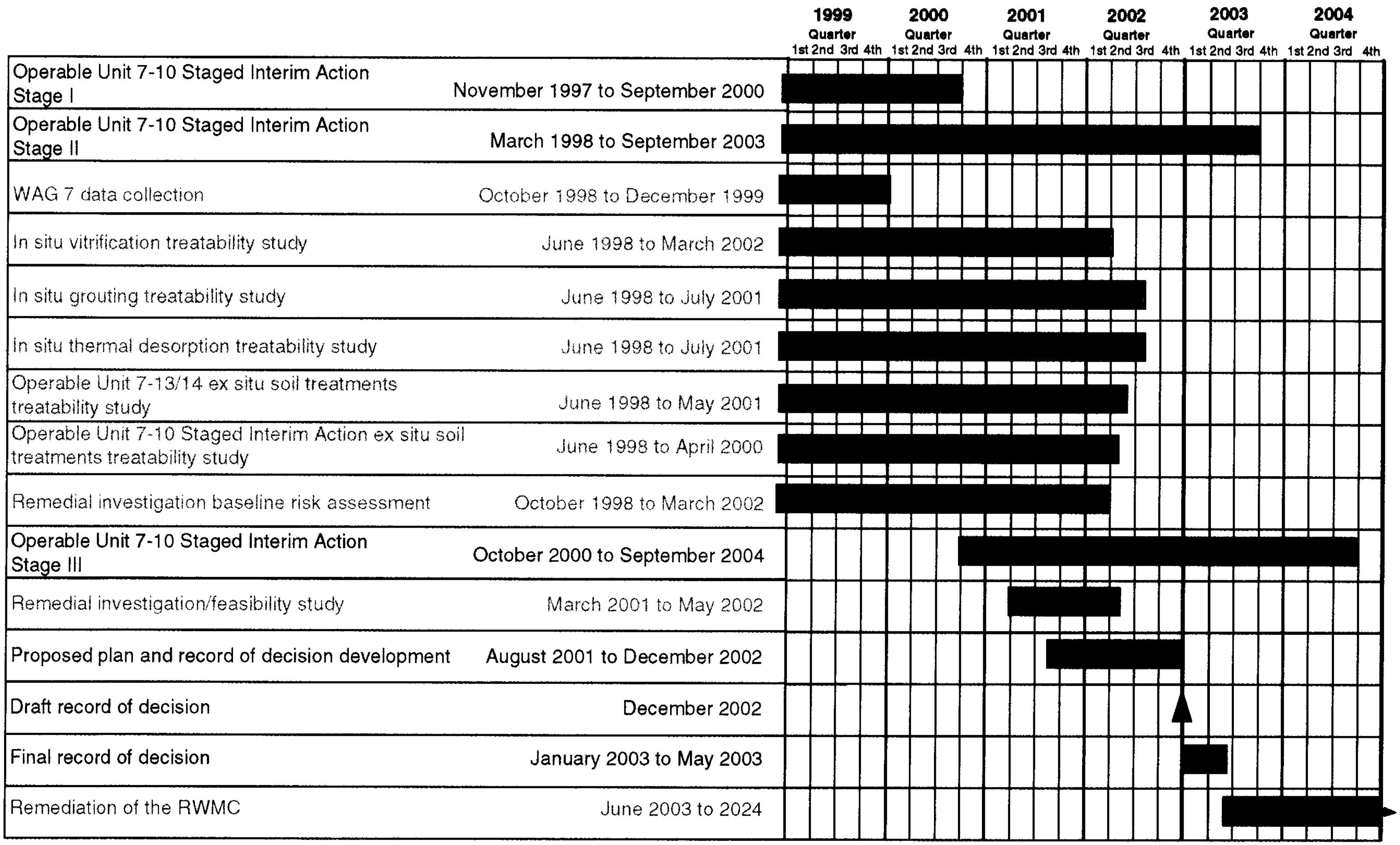

Figure 5. Schedule of major work activities for the Radioactive Waste Management Complex comprehensive investigation record of decision.

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